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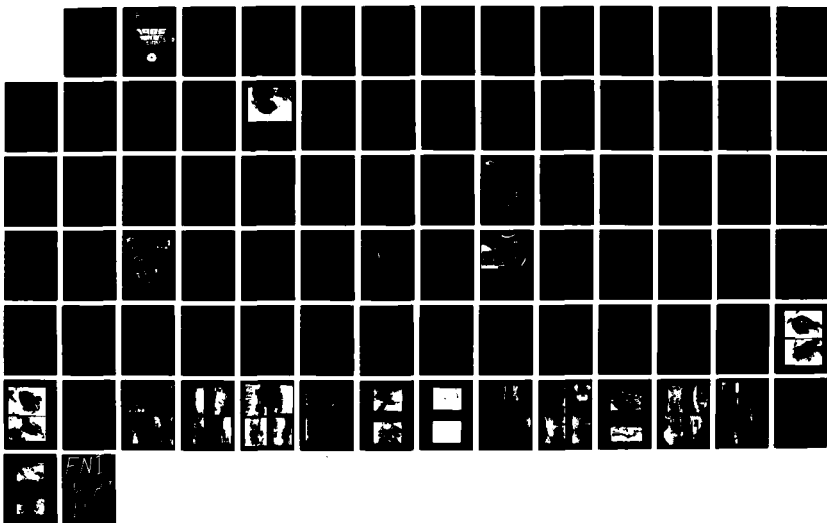
1985 HURRICANES: JUAN DANNY ELENA(U) RED RIVER BASIN
COORDINATING COMMITTEE NEW ORLEANS LA MAY 87

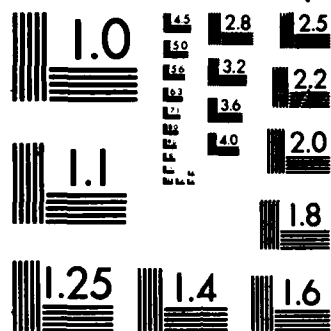
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US Army Corps
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New Orleans District

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FOREWORD

The coastline of Louisiana is highly susceptible to hurricane strength storms which enter the area from the Gulf of Mexico. During a normal hurricane season, which extends from June 1st to November 30th, the Louisiana coast will experience on an average about one hurricane per year. However, during the 1985 hurricane season, Louisiana was struck by three hurricanes: DANNY in August, ELENA in September, and JUAN in October.

While the first hurricane (DANNY) was not intense, the second (ELENA) and third (JUAN) were stronger and, more importantly, erratic and dilatory in making landfall. Waves generated by JUAN battered the Louisiana coast for at least 3 days. It is difficult to relate the severity of these events to a design storm, but it appears reasonable to conclude that the combined impact of the season's storms well exceeded that which would be associated with the passage of a design hurricane, which would occur once in 100 years.

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**ATLANTIC OCEAN AND GULF OF MEXICO
STORMS DURING 1985 HURRICANE SEASON**

THERE WERE 4 TROPICAL STORMS AND 7 HURRICANES THIS SEASON:

- "ANA" -Tropical storm that hit Newfoundland in mid July.
- "BOB" -Hurricane in late July that hit Florida and South Carolina.
- "CLAUDETTE" -Hurricane in mid August that remained at sea.
- "DANNY" -Hurricane in mid August that hit southwest Louisiana, causing 3 deaths and an estimated \$20 million in damages.
- "ELENA" -Hurricane in early September that threatened the west coast of Florida before looping clockwise and striking Mississippi and Louisiana, causing 4 deaths and an estimated \$25 million in damages.
- "FABIAN" -Tropical storm in mid September that remained at sea.
- "GLORIA" -Hurricane in late September that hit the east coast of the United States, causing 11 deaths and an estimated \$500 million in damages.
- "HENRI" -Tropical storm in late September that hit the northeastern coast of the United States.
- "ISABEL" -Tropical storm in early October that hit Puerto Rico, causing 100 deaths as a result of flash floods and mudslides; the storm then proceeded north and hit the Georgia coast.
- "JUAN" -Hurricane in Late October that struck southern Louisiana and parts of Alabama, Florida, Georgia, and Tennessee, causing 12 deaths and an estimated \$800 million in damages.
- "KATE" -Hurricane in late November that hit the Florida panhandle, causing 6 deaths and an estimated \$500 million in damages.

Data provided by the National Weather Service

INTRODUCTION

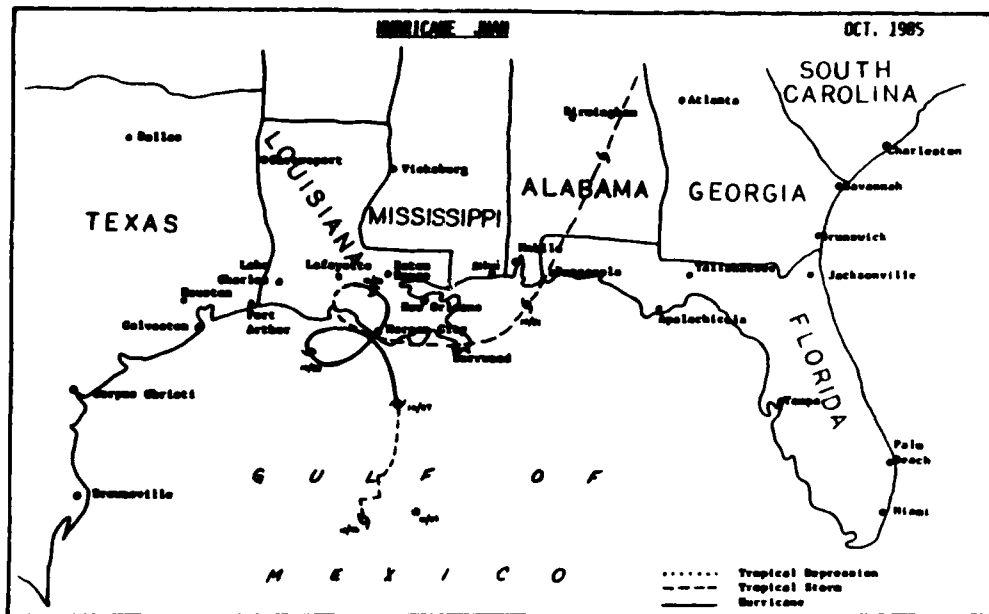
AUTHORITY. This report of hurricane activities that affected the Corps' New Orleans District (NOD) during 1985 has been prepared in accordance with ER 500-1-1 dated December 21, 1983.

(cont. to p. 1)

PURPOSE. The purpose of this report is to serve as a reference source for information relative to, ^{These three areas} Hurricanes JUAN, DANNY and ELENA. The primary areas of concern are the parishes in south Louisiana that experienced extensive damage from coastal and tidal flooding during Hurricane JUAN and were declared disaster areas by President Reagan, ^{1 Nov 85} on November 1, 1985. > Brief narratives and pertinent data on Hurricanes DANNY and ELENA follow the more detailed information and data on JUAN. < Please bear in mind that the intent of this report is only to identify and describe the significant events, damages, activities, and operations that resulted from the storms, particularly those that the Corps of Engineers were involved with. Also, please note that there is additional hydrological, meteorological, and photographic data available at the Corps' New Orleans District, Post Office Box 60267, New Orleans, Louisiana 70160-0267.

NARRATIVE

JUAN was described as an erratic moving, unorganized and unpredictable minimal hurricane (Category 1), yet it caused more damage and deaths than any of the other five hurricanes that struck the United States in 1985.



(Figure 1)

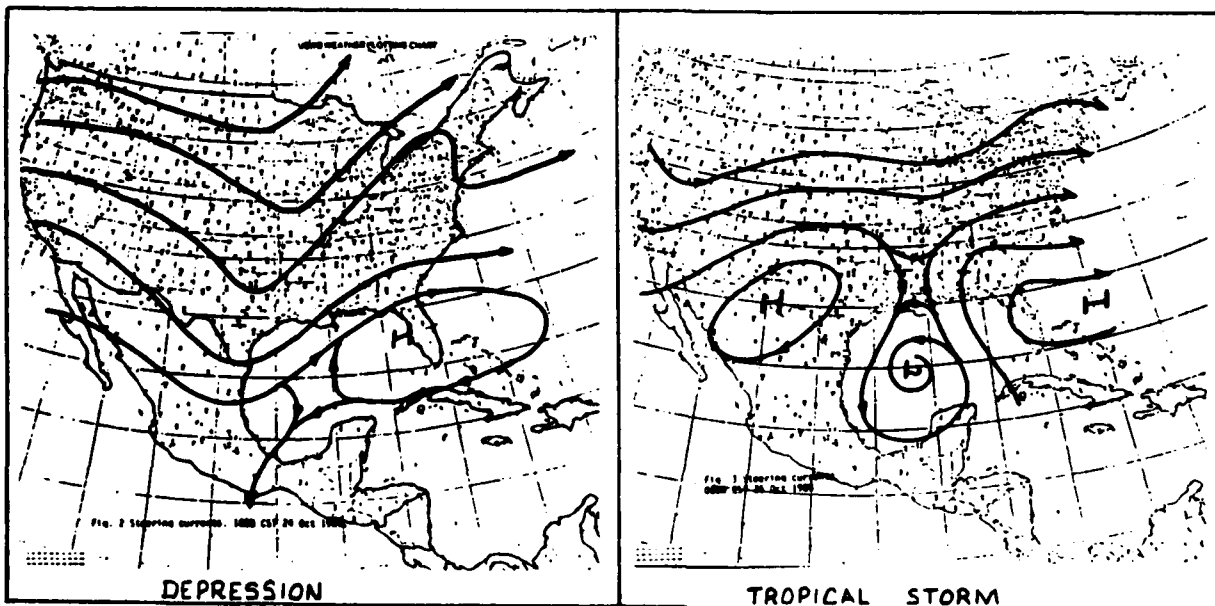
On October 25th, the National Weather Service (NWS) reported that a tropical depression had formed in the central Gulf of Mexico, and the following morning, National Oceanic and Atmospheric Administration (NOAA) reconnaissance aircraft reports indicated the winds had increased to tropical storm strength (39 MPH). In the early morning hours of October 27th, the storm began moving erratically toward the northeast at about 11 miles per hour (MPH). That afternoon, NOAA aircraft reports indicated the winds had reached hurricane force (74 MPH) and the storm was turning toward the northwest, heading toward Morgan City, Louisiana. By October 28th, JUAN's forward speed had dropped to less than 6 MPH and the storm merely drifted just off the central Louisiana coast, causing extremely high inland tides throughout southern Louisiana. With a lack of steering currents present, the storm drifted toward Texas during the next 24 hours before looping back toward the east and making landfall near Morgan City on the morning of October 29th.

Since the storm was highly unorganized, it was expected to lose strength quickly and diminish once over land. However, this loss of strength did not occur as expected and JUAN continued toward Lafayette, Louisiana, where it turned southeastward and headed back to the Gulf of Mexico. JUAN was downgraded to a tropical storm that evening, but maintained winds of 65 MPH. A second loop occurred on October 30th, with JUAN emerging over Vermilion Bay. After moving off shore, the storm became a little better organized and stronger westerlies pushed it eastward across the Gulf Coast. JUAN made a second landfall on October 31st just west of Pensacola, Florida, and continued northward through Alabama into central Tennessee, where it was eventually classified an extratropical storm. (The daily coordinates, velocities, and movement of Hurricane JUAN are shown at the end of the Meteorological and Hydrological Data Section).

METEOROLOGICAL AND HYDROLOGICAL DATA

Hurricane JUAN had a very slow and erratic path due to a lack of influential lower atmospheric conditions to control the storm once it developed. Additionally, a large scale upper level low pressure area around the storm produced shifting steering currents which made forecasting the motion extremely difficult.

The tropical depression formed when a westward moving tropical pressure wave moved into the northwest Gulf of Mexico and interacted with a trough moving off the Texas coast (Figure 2). JUAN became a tropical storm in the central Gulf of Mexico during the early morning hours of October 26th (Figure 3). Note that at this time the westerlies are far to the north of the low pressure system in the Gulf.

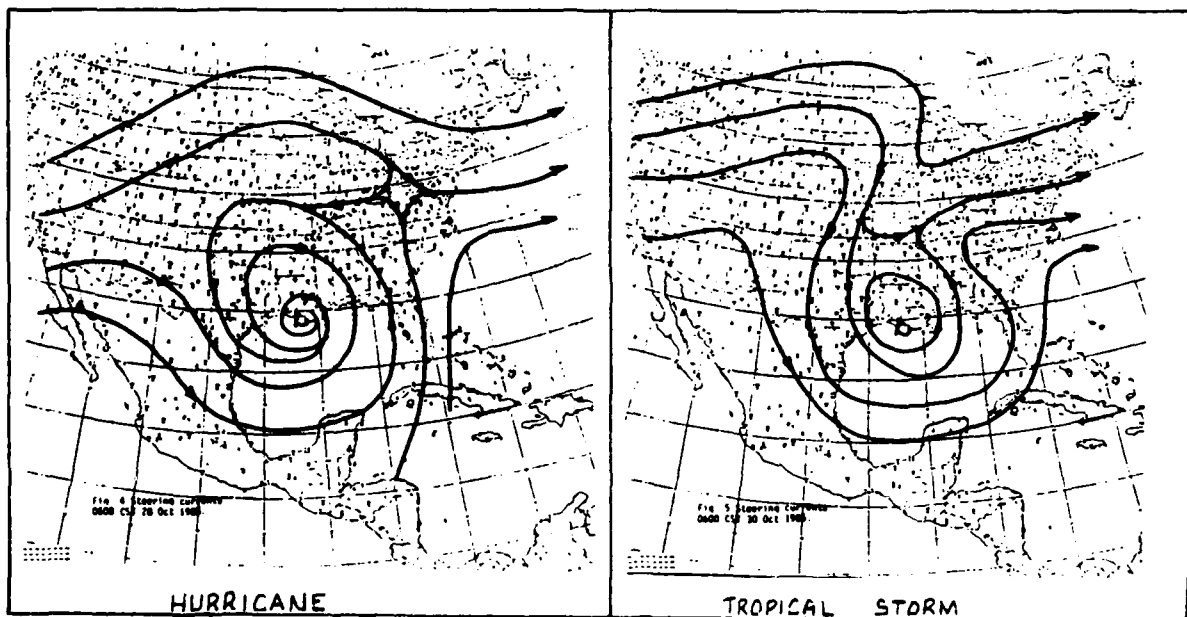


(Figure 2)

(Figure 3)

With no lower level controlling factors available to influence the storm's movement, it hovered over the Gulf, feeding off the warm water, and became a hurricane on the afternoon of October 27th. The weak southern branch of westerlies hooked up

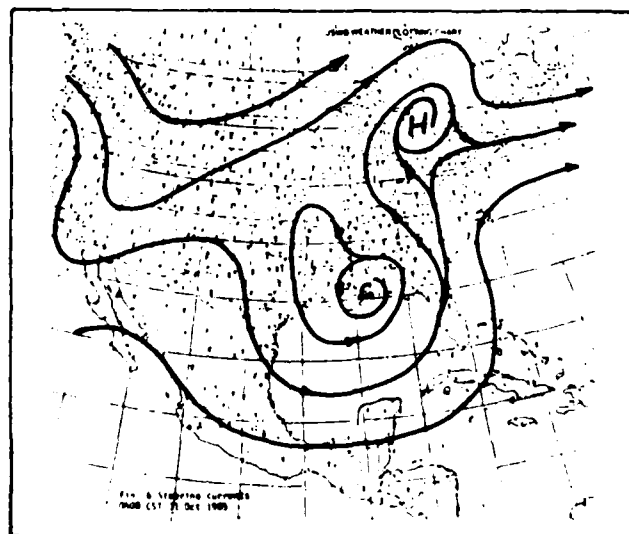
with JUAN on October 28th (Figure 4), but were not strong enough to influence the storm. Consequently, the low pressure system was allowed to drift over Louisiana for several days (Figure 5) without much frictional force to break up the storm.



(Figure 4)

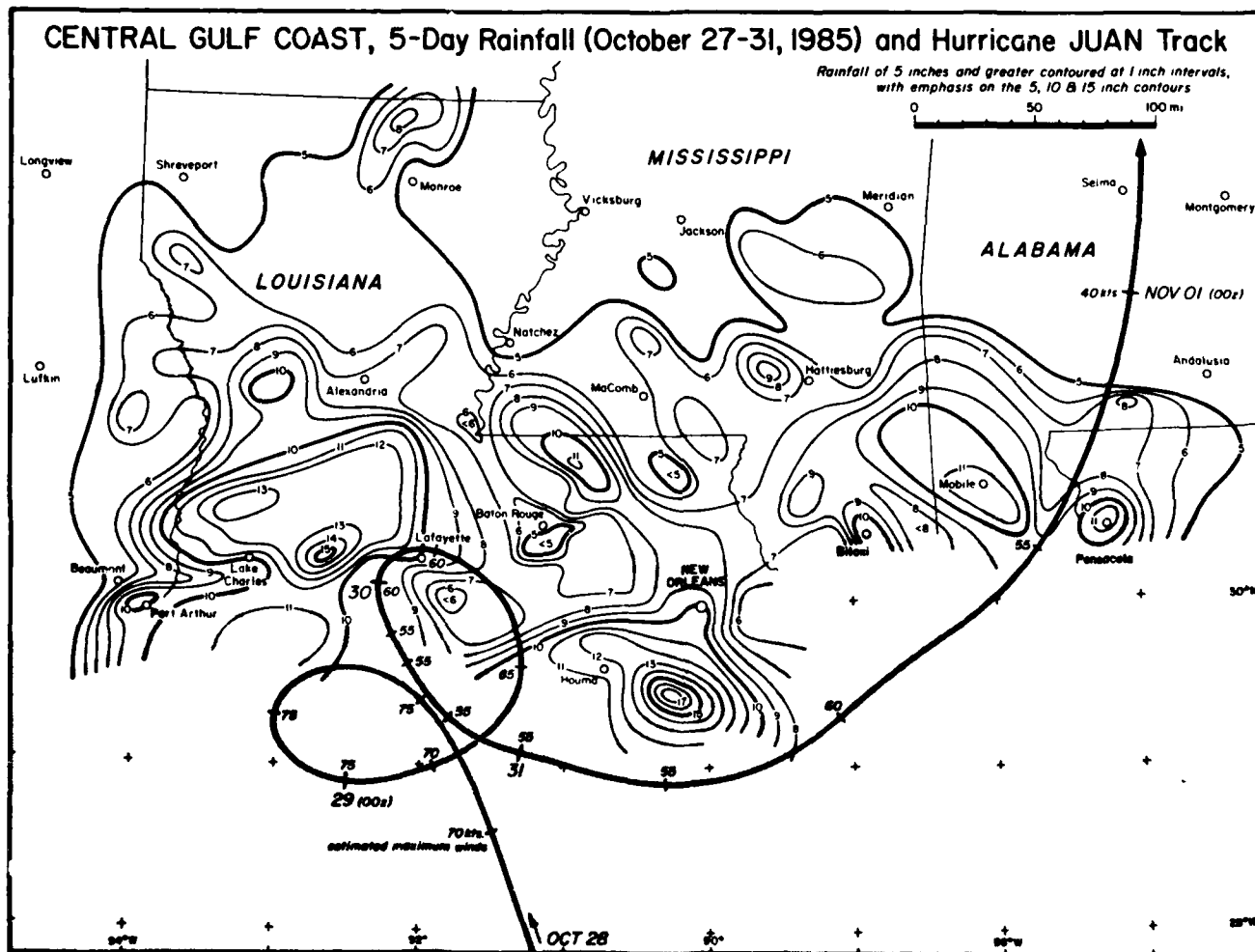
(Figure 5)

It was not until October 31st that the westerlies were strong enough to influence JUAN and push it away from Louisiana (Figure 6).



(Figure 6)

The maximum sustained wind and lowest pressure reported by NOAA reconnaissance aircraft was 86 MPH (75 knots) and 971mb, respectively, on October 28th. Rainfall amounts in excess of 5 inches were reported in all Gulf Coast states, with two areas in Louisiana reporting more than 15 inches. For a better idea of wind speeds and rainfall amounts see Figure 7 below.



(Figure 7)

Tides were generally 3 to 6 feet above normal along the coast. East of the Mississippi River these tides persisted for most of the 5-day period. For tide gage information see Table 1. Storm surges of 5 to 8 feet were reported in several coastal parishes of Louisiana.

Throughout most of southern Louisiana high tides and excessive rainfall combined to flood more than 5,000 homes and businesses and approximately 3,260,000 acres of land (see Table 2 for number of acres flooded by parish, as determined by the use of enhanced satellite imagery). Reports from the Louisiana Office of Emergency Preparedness (LA OEP) indicate that there were approximately \$304 million of damage to property and \$250 million of damage to crops (mostly soybean and sugar cane) caused by flooding. Wind damage was relatively insignificant.

TABLE 1
HURRICANE JUAN
MAXIMUM STAGES
27 Oct - 7 Nov 85

Station	Code No.	Date/Time	Stage (ft NGVD)
Mississippi River @ Bonnet Carre LA	01280	27 Oct/2400	8.67
Mississippi River @ New Orleans (Carrollton) LA	01300	28 Oct/0130	8.71
Mississippi River @ Chalmette LA	01360	28 Oct/0115	8.33
Mississippi River @ Algiers Lock LA	01380	28 Oct/0800	7.56
Mississippi River nr Braithwaite, LA	01386	28 Oct 0130	7.45
Mississippi River @ Alliance LA	01390	28 Oct/0045	7.14
Mississippi River @ West Pointe a la Hache LA	01400	27 Oct/2230	6.43
Mississippi River @ Empire LA	01440	27 Oct/2230	6.05
Mississippi River @ Venice LA	01480	27 Oct	FIR 5.31
Mississippi River @ Head of Passes LA	01545	27 Oct/2030	3.95
Mississippi River (SW Pass) @ East Jetty LA	01670	27 Oct/2015	*5.59
South Pass @ Port Eads, LA	01850	27 Oct	FIR 3.93
Whiskey Bay Pilot Channel below Head LA	03240	30 Oct/1500	12.78
Blind Tensas Cut below Upper Grand River LA	03315	30 Oct/1630	10.65
Chicot Pass nr Myette Point LA	03540	29 Oct/0830	8.19
Grand Lake @ Charenton LA	03555	29 Oct/1030	6.21
Six Mile Lake nr Verdunville LA	03645	28 Oct/0100	6.86
Lower Atchafalaya River @ Berwick Lock LA (West)	03750	29 Oct/0030	3.38
Lower Atchafalaya River @ Morgan City LA	03780	28 Oct/1329	5.4
Lower Atchafalaya River below Sweet Bay Lake LA	03820	28 Oct/1230	5.51
Round Bayou @ Deer Island LA	03850	28 Oct/1100	*4.98
Upper Grand River (FWS) @ Dike LA	49570	31 Oct/1500	8.12
Big Bayou Pigeon nr Pigeon LA (FWS)	49635	31 Oct/0330	5.70
Old River (FWS) @ Junction w/GIWW (Morgan City - Port Allen Route) LA	49645	29 Oct/1400	4.97
Little Bayou Sorrel @ Jct w/GIWW (Morgan City - Port Allen Route) LA	49725	29 Oct/1100	5.17
Intracoastal Waterway @ Morley LA	52441	29 Oct/2300	7.02
Belle River nr Pierre Pass LA	52640	1 Nov/0800	*5.1
Pierre Pass @ Pierre Part LA	52680	29-30 Oct/0800	4.2
Lake Verret @ Attakapas Landing LA	52720	30-31 Oct/0800	4.25
Lake Palourde nr Morgan City LA	52750	29 Oct/0550	4.18
Bayou Boeuf @ Amelia LA	52800	30 Oct/0245	3.60
Bayou Black @ Greenwood LA	52880	30 Oct/1830	3.49
Bayou Teche @ Keystone Lock (Upper)	64200	29 Oct/1600	11.27
Bayou Teche @ Keystone Lock (Lower)	64250	29 Oct/1600	10.92
Charenton Drainage Canal nr Floodgate LA	64400	29 Oct/0800	4.28
Charenton Drainage Canal @ Baldwin LA	64450	29 Oct/0000	3.95
Bayou Teche @ West Calumet Floodgate LA	64650	29 Oct/0800	4.2
Mermentau River @ Lacassine Refuge (LA)	70600	4 Nov/1400	5.11
Mermentau River @ Catfish Point Control Structure (North)	70675	28 Oct/1125	4.36
Mermentau River @ Catfish Point Control Structure (South Auto)	70750	No record	

TABLE 1 (Continued)
HURRICANE JUAN
MAXIMUM STAGES
27 Oct - 7 Nov 85

Station	Code No.	Date/Time	Stage ft NGVD)
Mermentau River @ Grand Cheniere LA	70900	2 Nov/0630	3.87
Calcasieu River Salt Water Barrier Channel @ Lake Charles LA (Nav W)	73473	1 Nov/0900	3.57
Calcasieu River & Pass @ Lake Charles LA	73550	2 Nov/0300	3.91
Calcasieu River & Pass @ Hackberry LA	73600	1 Nov/2400	2.52
Calcasieu River & Pass nr Cameron LA	73650	2 Nov/0415	3.26
Bayou Dupre @ Floodgate (West) LA	76005	30 Oct/0530	*3.53
Bayou Dupre @ Floodgate (East) LA	76010	28 Oct/1420	*7.61
Bayou Bienvenue @ Floodgate (West) LA	76024	29 Oct/1130	3.78
Bayou Bienvenue @ Floodgate (East) LA	76025	28 Oct/1415	*7.98
Intracoastal Waterway nr Paris Road Bridge, New Orleans LA	76040	27 Oct	FIR 7.7
Inner Harbor Navigation Canal nr Seabrook Bridge, New Orleans LA	76060	No record	
Inner Harbor Navigation Canal @ Florida Ave Bridge, New Orleans LA (observed)	76120	28 Oct	7.34
Intracoastal Waterway @ Harvey Lock LA	76200	29 Oct/1300	*4.74
Intracoastal Waterway @ Algiers Lock	76240	29 Oct/1200	*4.45
Bayou Petit Caillou @ Cocodrie LA	76305	27 Oct	FIR 7.0
Intracoastal Waterway @ Houma LA	76320	29 Oct/1530	*5.16
Bayou Boeuf (IWW) @ Bayou Boeuf Lock LA (East)	76360	29 Oct/0800	*3.6
Bayou Boeuf (IWW) @ Bayou Boeuf Lock LA (West)	76400	28 Oct/1600	5.39
Intracoastal Waterway @ Wax Lake East Control Structure LA	76440	28 Oct	4.4
IWW @ Wax Lake West Control Structure LA	76560	28 Oct/2000	4.68
Freshwater Canal above Beef Ridge LA	76590	28 Oct/2100	4.47
Freshwater Canal @ Freshwater Bayou Lock LA (South)	76593	28 Oct/1424	4.95
Schooner Bayou (Inland Waterway) @ Control Structure LA (East Auto)	76600	28 Oct/2000	5.22
Schooner Bayou Control Structure (West)	76680	30 Oct/1126	3.4
IWW @ Leland Bowman Lock LA (East Auto)	76720	28 Oct/0635	5.7
IWW Leland Bowman Lock (West)	76800	29 Oct/1600	3.7
IWW @ Calcasieu Lock (East)	76880	29 Oct/0515	2.40
IWW @ Calcasieu Lock LA (West Auto)	76960	2 Nov/0100	2.79
Bayou Lafourche @ Leeville, LA	82350	28 Oct/0400	*6.62
Bayou Chevreuil nr Chegby LA	82525	31 Oct/0800	3.86
Bayou Des Allemands @ Des Allemands LA	82700	29 Oct/1600	*3.92
Bayou Barataria @ Barataria LA	82750	29 Oct/1330	4.25
Bayou Barataria @ Lafitte LA	82875	29 Oct/0330	*5.05
Alligator Bayou @ Spanish Lake Floodgate (Upper) LA	85050	1-7 Nov	8.00
Alligator Bayou @ Spanish Lake Floodgate (Lower) LA	85075	2 Nov/1500	10.89
Petite Amite River nr St. Paul LA	85250	No record	
Reserve Canal nr Lake Maurepas LA	85275	29-30 Oct	FIR *5.5
Tickfaw River nr Springfield LA	85300	30 Oct/1201	*6.51

TABLE 1 (Continued)
HURRICANE JUAN
MAXIMUM STAGES
27 Oct - 7 Nov 85

Station	Code No.	Date/Time	Stage ft NGVD)
Pontchatoula Creek nr Pontchatoula LA	85350	29 Oct/1430	10.90
Lake Pontchartrain @ Frenier LA	85550	29 Oct/0800	7.58
Lake Pontchartrain @ Mandeville LA	85575	28 Oct/0600	6.5
Lake Pontchartrain @ Midlake nr New Orleans LA	85600	29 Oct/1400	*6.14
Lake Pontchartrain @ West End LA	85625	28 Oct/1000	*6.11
Lake Pontchartrain (Irish Bayou) nr South Shore LA	85675	28 Oct	FIR 6.0
Rigolets nr Lake Pontchartrain LA	85700	28 Oct/0630	5.74
Lake Borgne @ Rigolets LA	85725	No record	
Chef Menteur Pass nr Lake Borgne LA	85750	28 Oct/0100	6.25
Bayou Terre Aux Boeufs @ Delacroix LA	85780	28 Oct/0400	*6.86
Mississippi River-Gulf Outlet @ Shell Beach LA	85800	High water mark	7.5
Grand Isle East Point LA	88400	27 Oct/2154	5.63
Grand Isle Hurricane Gage		27 Oct	5.41
Atchafalaya Bay nr Eugene Island LA	88550	28 Oct/1000	*4.68
Atchafalaya Bay @ Eugene Island LA	88600	28 Oct/1000	4.05
East Cote Blanche Bay @ Lukes Landing LA	88800	28 Oct/1000	6.63
Empire Floodgate, Plaquemines Parish LA		28 Oct/0900	4.90

FIR From Incomplete Records

* Record high

TABLE 1 (Continued)
HURRICANE JUAN
MAXIMUM STAGES
27 Oct - 7 Nov 85

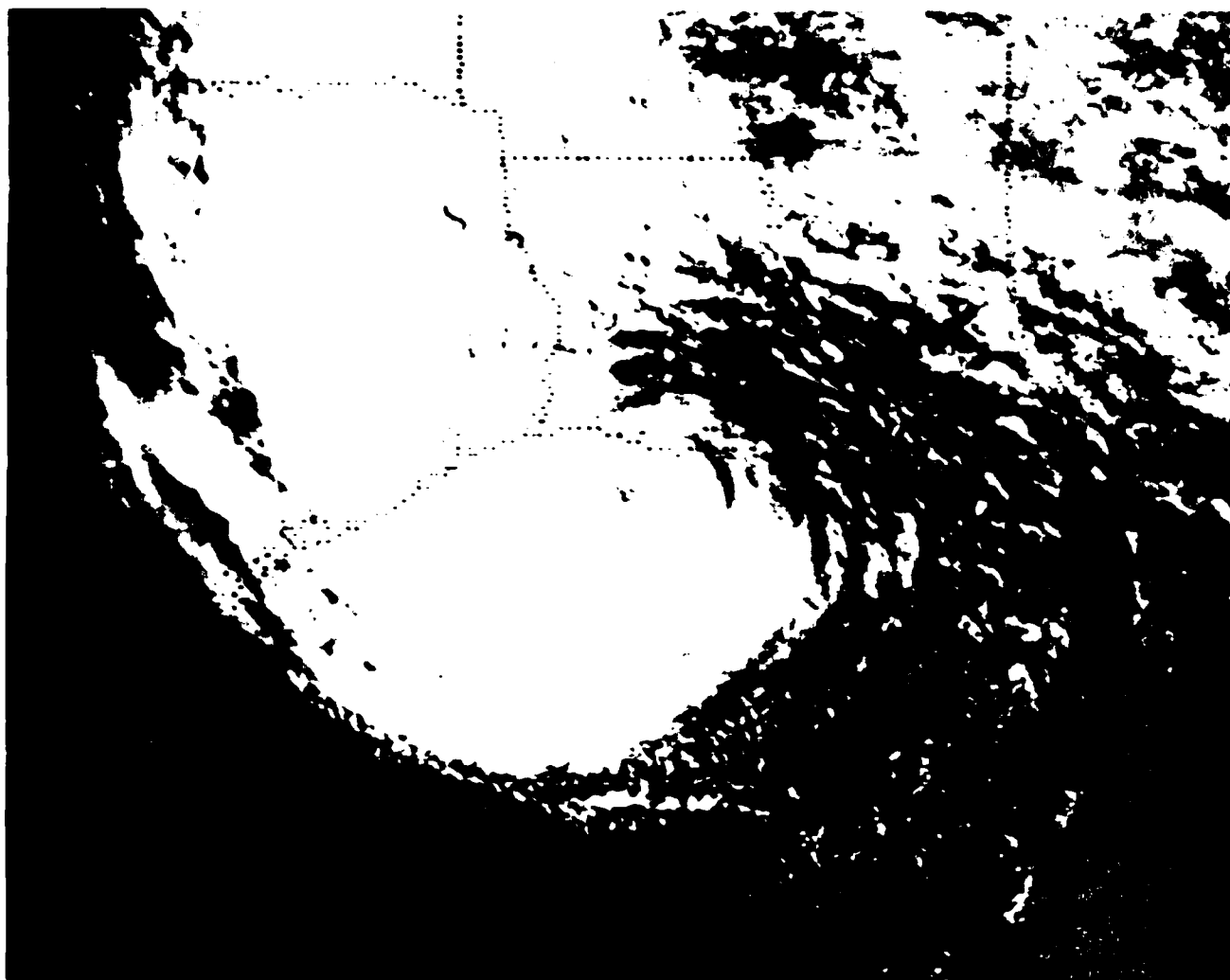
NEW RECORDS ESTABLISHED

<u>Station</u>	<u>New Reading</u>	<u>Previous High</u>	<u>Gage Installed</u>
Mississippi River @ SW Pass East Jetty	5.59 NGVD	5.50 27 Oct 72	1926
Round Bayou @ Deer Island	4.98	4.56 24 Jul 79	1974
Belle River near Pierre Pass	5.10	4.90 20 Apr 73	1955
Bayou Dupre @ Floogate (West)	3.53	3.49 13 Apr 80	1975
Bayou Dupre @ Floodgate (East)	7.61	4.51 23 Jul 79	1975
Bayou Bienvenue @ Floodgate (East)	7.98	4.68 13 Apr 80	1974
IWW @ Harvey Lock	4.74	4.21 18 Apr 73	1925
IWW @ Algiers Lock	4.45	4.31 18 Apr 73	1956
IWW @ Houma	5.16	4.75 10 Oct 78	1941
Bayou Lafourche @ Leeville	6.62	5.66 8 Sep 74	(Carmen) 1955
Bayou Des Allemands	3.92	3.74 22 Apr 73	1950
Bayou Barataria @ Lafitte	5.05	4.04 4 Oct 64	1955
Reserve Canal near Lake Maurepas	5.50	3.65 13 Apr 80	1979
Tickfaw River near Springfield	6.51	5.57 25 Apr 79	1947
Lake Pontchartrain @ Midlake	6.14	5.53 10 Sep 65	(Betsy) 1957
Lake Pontchartrain @ West End	6.11	5.37 9 Sep 65	(Betsy) 1931
Bayou Terre Aux Boeufs @ Delacroix	6.86	3.08 1 Sep 77	(Babe) 1975
Atchafalaya Bay near Eugene Island	4.68	4.50 24 Jul 79	1976

TABLE 2
HURRICANE JUAN FLOODED AREAS

<u>Parish</u>	<u>*Flooded Area (Acres)</u>
St. Bernard	31,087
Plaquemines	41,848
Orleans	13,550
Jefferson	17,138
St. Tammany	11,956
Tangipahoa	73,333
Livingston	97,246
St. Charles	142,681
St. John the Baptist	96,848
St. James	45,833
Ascension	58,985
Assumption	62,572
Lafourche	310,072
Terrebonne	165,797
St. Martin	178,152
St. Mary	306,485
Iberia	51,812
Iberville	161,413
St. Landry	117,174
Lafayette	13,551
Acadia	204,855
Vermilion	484,637
Cameron	453,151
Jefferson Davis	37,862
Calcasieu	23,514
Pointe Coupee	43,442
 TOTAL	 3,259,342

* Determined by the use of enhanced satellite imagery.



Satellite view of Hurricane JUAN as it was centered just offshore of the Louisiana

(For daily satellite photos of JUAN over the
Louisiana and Gulf Coasts, see PHOTO SECTION)

HURRICANE JUAN

OCT. 1985

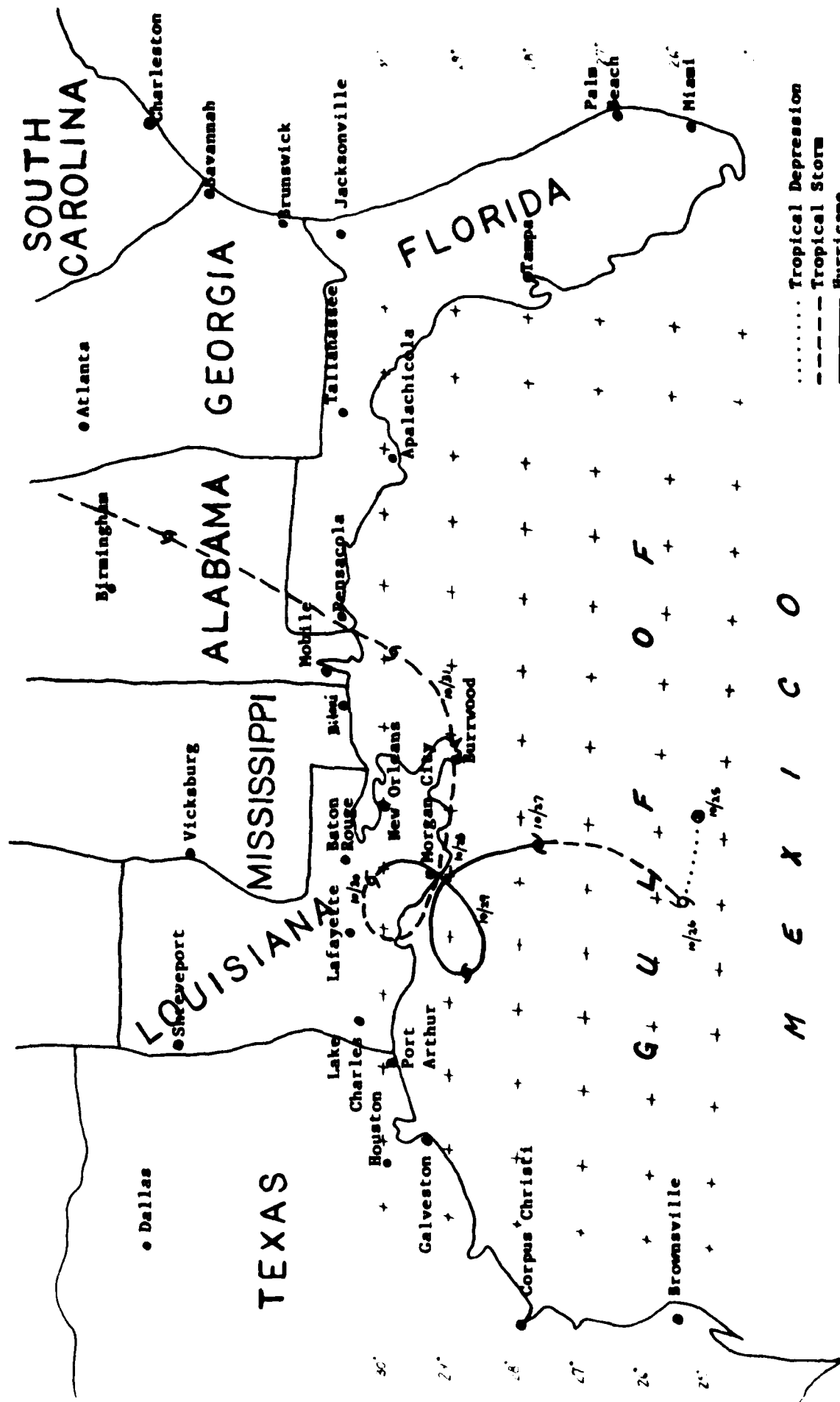


TABLE 3

HURRICANE JUAN'S TRACK

DATE	TIME	LATITUDE	LONGITUDE	MAXIMUM VELOCITY	MOVEMENT & SPEED	REMARKS
10/25	2200	24.0 N	91.0 W	35 MPH	W @ 5 MPH	DEPRESSION
10/26	1130	24.5 N	92.5 W	45 MPH	W @ 5	TROP. STORM
10/26	1800	24.5 N	93.0 W	45 MPH	W @ 5	
10/26	2200	24.5 N	93.0 W	45 MPH	STATIONARY	
10/27	0400	25.5 N	92.0 W	55 MPH	DRIFTING N	
10/27	1000	26.0 N	91.7 W	70 MPH	N @ 5	
10/27	1300	26.5 N	91.3 W	75 MPH	N @ 7	HURRICANE
10/27	1600	27.0 N	91.0 W	75 MPH	NNE @ 7	
10/27	1900	28.0 N	91.0 W	75 MPH	NNE @ 15	
10/27	2200	28.5 N	91.3 W	85 MPH	NNW @ 15	LOOP 1
10/28	0100	29.0 N	91.5 W	85 MPH	NNW @ 15	
10/28	0300	29.1 N	91.7 W	85 MPH	NNW @ 15	
10/28	0500	29.2 N	92.0 W	85 MPH	NNW @ 10	
10/28	0700	29.5 N	92.2 W	85 MPH	NW @ 10	
10/28	1000	29.6 N	93.0 W	85 MPH	DRIFTING NNW	
10/28	1200	29.3 N	93.0 W	85 MPH	DRIFTING S	
10/28	1400	29.1 N	92.8 W	85 MPH	DRIFTING SE	
10/28	1800	29.1 N	92.4 W	85 MPH	DRIFTING E	
10/28	2200	29.0 N	92.2 W	85 MPH	DRIFTING SE	
10/28	2400	28.9 N	92.0 W	85 MPH	DRIFTING E	
10/29	0400	29.0 N	91.0 W	85 MPH	ENE @ 10	
10/29	0600	29.5 N	91.0 W	85 MPH	N @ 10	LANDFALL
10/29	0800	29.8 N	91.1 W	85 MPH	NNW @ 10	
10/29	1000	30.1 N	91.3 W	75 MPH	NW @ 7	
10/29	1200	30.2 N	91.6 W	75 MPH	WNW @ 5	
10/29	1400	30.3 N	91.9 W	75 MPH	WNW @ 6	
10/29	1600	30.3 N	92.2 W	65 MPH	W @ 6	TROP. STORM
10/29	1900	30.4 N	92.2 W	65 MPH	DRIFTING N	
10/29	2200	30.0 N	92.5 W	65 MPH	SW @ 5	
10/30	0100	30.0 N	92.7 W	60 MPH	DRIFTING W	
10/30	0400	29.5 N	92.0 W	60 MPH	ESE @ 5	LOOP 2
10/30	1200	29.4 N	92.0 W	60 MPH	STATIONARY	
10/30	1600	29.4 N	91.7 W	60 MPH	DRIFTING E	
10/30	2200	29.3 N	90.5 W	60 MPH	ESE @ 7	
10/31	0100	29.0 N	90.0 W	60 MPH	ESE @ 10	
10/31	0400	29.0 N	89.5 W	60 MPH	E @ 10	
10/31	0700	29.4 N	88.8 W	70 MPH	NE @ 20	
10/31	1000	30.0 N	88.0 W	70 MPH	NE @ 20	
10/31	1300	30.4 N	87.7 W	55 MPH	NE @ 20	LANDFALL
10/31	1600	31.2 N	86.9 W	55 MPH	NE @ 15	
10/31	1900	32.0 N	87.0 W	50 MPH	N @ 15	

HIGHLIGHTS OF STORM DAMAGES

JUAN's lingering over the Louisiana coast and northwest Gulf of Mexico for nearly 4 days caused extremely high tides (3 to 6 feet above normal) in many southern Louisiana parishes. High tides combined with extensive rainfall caused some of the most intense flooding in this part of the state in several years. The high tides saturated and eventually overtopped or breached many locally constructed dikes, causing flood damage to numerous developed areas and thousands of acres of agricultural land.

There were some damages reported in 26 Louisiana parishes; however, only 12 parishes qualified for the presidential disaster declaration made on November 1, 1985. The 12 parishes included Jefferson, Terrebonne, Lafourche, St. Bernard, St. Charles, Ascension, St. John the Baptist, Orleans (Ward 9 only), Livingston, St. Tammany, Tangipahoa, and Plaquemines.

Rainfall was excessive from southeast Texas to southern Alabama due to the length of time JUAN remained over that area. Rainfall totals ranged from 5 to 10 inches, with some isolated local amounts of 17 inches reported in Louisiana. The total number of acres of land flooded as a result of Hurricane JUAN was approximately 3,260,000 (26 parishes) and approximately 1,110,000 acres were within the disaster areas (12 parishes). A breakdown of the flooded acres in each parish is shown in Table 2 of this report. Reports from LA OEP indicate that over \$554 million in damage to property and crops was caused by flooding within Louisiana.

There were 12 deaths attributed to JUAN - 11 in Louisiana and 1 in Texas. Nine deaths in Louisiana were caused by toppled oil rigs or by overturned boats transporting oil workers; the other deaths were caused by an electrocution and drowning in Louisiana, and a drowning off the coast of Texas. There were 1,357 injuries reported by the Federal Emergency Management Agency (FEMA), with most being considered minor.

The total estimated dollar damages reported by the National Weather Service, including most of Louisiana and parts of Alabama, Florida, Georgia, and Tennessee, is \$800 million. The estimated dollar damages prevented by existing Federal hurricane protection projects within Louisiana is \$900 million.

THE INCIDENT PERIOD

Saturday, October 26th

High tides east of the Mississippi River forced the closing of Bayou Bienvenue and Bayou Dupre control structures in Orleans and St. Bernard Parishes, respectively.

Sunday, October 27th

The NOD Emergency Management personnel began manning the Emergency Operations Center (EOC) at noon and later commenced with 24-hour operations. The EOC remained in this mode until Friday, November 1st.

Heavy rainfall and some flooding outside the Federal hurricane protection system was occurring east of the Mississippi River in St. Bernard and Plaquemines Parishes. Contacts with local levee district officials confirmed that they had closed the Empire floodgate in Plaquemines Parish, the Golden Meadow floodgate in Lafourche Parish, floodgates along the Inner Harbor Navigation Canal (IHNC) in Orleans Parish, and the floodgates in the Berwick and Morgan City floodwalls in St. Mary Parish. Additionally, the IHNC was closed to navigation for several hours due to reverse head conditions at the lock, and the Lake Pontchartrain Causeway was closed due to hazardous driving conditions.

Along Lake Pontchartrain at the old amusement park (Pontchartrain Beach) site, the Orleans Levee District had to construct a sandbag dike to fill the intentional gap in the Federal hurricane protection system. The sandbag dike was later tested by small waves from the lake and proved to be adequate.

NOTE: The Orleans Levee District completed Phase 1 construction of an earthen levee through this area in July 1986.

Monday, October 28th

This morning an oil rig capsized in the Gulf of Mexico and six people drowned.

With the hurricane approaching landfall and extremely high inland tides and heavy rainfall prevailing, advanced protection measures were being accelerated by all agencies (Federal, state and local) in those areas between Galveston, Texas and the Mississippi River. Levees and dikes were being raised, evacuations were being conducted, and construction sites were being secured.

In St. Mary Parish, hurricane winds forced high tides to overtop a Federal flood control levee near the Gordy Pumping Station; however, no significant damage resulted from the overtopping. All of the Corps-constructed pumping stations were in full operation. In the Morgan City area, the Corps' Lafayette Area Engineer issued a contract modification to raise the level of protection around floodwall construction sites to +9.0 feet National Geodetic Vertical Datum (NGVD), using sandbags. The Corps also evacuated personnel from Freshwater Bayou and Leland Bowman locks and from the Schooner Bayou control structure due to their isolated locations in southwest Louisiana.

Later that afternoon a failure occurred in a non-Federal levee at the Bully Camp Pumping Station in Lafourche Parish. The pump station sustained major damage, but more importantly, the failure allowed high tides to enter into a portion of the Larose to Golden Meadow hurricane protection system, which is under construction, and flooded several towns west of Bayou Lafourche. The failure occurred in a locally constructed levee that connected portions of the Federal hurricane protection project, where a gap was intentionally left in the project to allow local interests access to a new pumping station construction site. (See Exhibit 3 for location and status of project).

An aerial inspection by the Corps of the Grand Isle Hurricane Protection and Beach Erosion Project revealed that the sand dune and beach were significantly damaged - approximately 6,000 feet of dune was completely leveled; 14,000 feet seriously damaged; and 18,000 feet was undamaged. (See Exhibit 2 for locations)

Tuesday, October 29th

Having been saturated for several days, many back levees and dikes west of the Mississippi River had become structurally unsafe. The levees and dikes were being overtopped by high tides and some breached. The Corps loaned 28,000 sandbags to local interests during the night (early morning) to aid their efforts to prevent overtopping and control breaches. NOTE: In accordance with Corps of Engineers' policies, during working hours local interests were requested to procure sandbags that were readily available from local distributors. Additional to this direct support, engineers from the Corps were sent to the critical sites to provide technical assistance to local and state authorities on emergency action plans.

On the west bank in Jefferson Parish, there was a local levee failure along Harvey Canal at a pumping station construction site and a local levee failure near the Keyhole Canal at Westwego, Louisiana. Water coming through both failures was successfully diverted to nearby pumping stations, thereby preventing any flooding from occurring in residential neighborhoods. However, the Lincolnshire and Westminster Subdivision residents in nearby Marrero, Louisiana, were not as fortunate, as their homes were flooded by 3 to 4 feet of water when a local levee behind the subdivisions was overtopped by rising tides. (See Exhibit 7 for locations).

On the east bank in Jefferson Parish, East Jefferson Levee District personnel constructed a temporary earthen closure dike across Airline Highway (US 61) to prevent high tides from

Lake Pontchartrain from entering into the populated areas of Jefferson Parish. Simultaneously, levee district personnel were combatting what was originally thought to be sand boils in the Lake Pontchartrain west return levee (Item A) behind the airport. It turned out that the problem was actually seepage from a submerged electrical conduit that passed through the levee. No significant damage resulted from this problem and it was quickly repaired.

In Orleans Parish, the Orleans Levee District placed sandbags on the Algiers Canal west levee to prevent canal water from overtopping the levee at a low spot where a bridge crossing was being removed. In eastern New Orleans, a jack up-type oil rig capsized and sank in the Mississippi River - Gulf Outlet (MRGO) about 1/4 mile south of navigation light number 87. Three crew members drowned and deep draft traffic was temporarily blocked.

Because of the above problems along Algiers and Harvey Canals, where record water elevations (near +5.0 feet NGVD) were present, the Corps closed the navigation locks at the Mississippi River. This was necessary because the river elevation had risen above +8.0 feet NGVD and barge traffic in the canals would have adverse impacts on the problem areas.

In Lafourche Parish around the Larose to Golden Meadow project, matters were getting worse. In addition to the Bully Camp failure, another local levee failure had occurred at a gap east of Bayou Lafourche at Yankee Canal. Later that evening, high tides had reached the upper limit of the incompletd project, where no Federal levee existed, and began uncontrolled flow into the area. Approximately 90% of the land inside the project was flooded. Engineers from the Corps inspected the failure sites with local officials and emergency action plans were established.

In southwest Louisiana, Corps personnel that were evacuated yesterday from Freshwater Bayou and Leland Bowman locks and Schooner Bayou control structure returned to their facility and immediately opened the structures to allow water to drain to the Gulf.

The Corps' Pointe Coupee Pumping Station in central Louisiana had been operating on a 24-hour basis for the past few days. The stage at the pumping station was at 26.7 feet NGVD this date. Operation on a 24-hour basis would continue until the stage reached 20.0 feet NGVD, which occurred on Sunday, November 3rd.

Rainfall throughout southern Louisiana continued to be heavy. Morgan City had already recorded 10 inches of rain since JUAN had moved into the area, and New Orleans had recorded 8 inches.

Wednesday, October 30th

The failures at Harvey Pump Station and Keyhole Canal in Jefferson Parish were fully under control; however, a fourth failure was discovered later that afternoon. The locally-constructed "V" levee located south of Marrero began overtopping and eventually breached. A 300-foot section of levee was overtopping and a 30-foot section washed out, below the Estelle Pumping Station. All flooding from this problem area was confined to marshland. West Jefferson Levee District personnel with assistance from local residents placed sandbags on the levee crown to prevent overtopping and constructed a ring levee to prevent flow through the gap, as recommended by a consulting engineer whose services the levee district acquired to assist with their emergency operations.

At Bully Camp, Lafourche Parish officials made arrangements to obtain a pile driving contractor to drive steel sheetpiles to close the gap, and was seeking a source from which to procure the piles. Upon learning of this, the Corps determined necessary

sheetpile lengths and offered to loan the parish the necessary sheetpiles from its emergency stockpile at Bayou Boeuf lock. The Corps also loaned the parish and levee district 19 Crisafulli pumps to facilitate interior drainage. Additionally, tides outside the levee system had receded enough to allow South Lafourche Levee District personnel to open the Golden Meadow floodgate to facilitate drainage inside the system. Engineering assistance to the parish and levee district was provided throughout the recovery period.

Tides east of the Mississippi River had finally dropped and levee district personnel were able to open the Bayou Bienvenue and Bayou Dupre control structures. Floodgates along the Industrial Canal (IHNC) and in St. Mary Parish were still closed, as were the Algiers and Harvey locks.

Twenty (20) parish assistance team members from the Corps were dispatched to most of the devastated parishes to make windshield surveys - preliminary damage assessments. Aerial reconnaissance surveys were also being made. Governor Edwin Edwards had inspected the damaged areas and declared a "State-of-Emergency" in 26 parishes. He also requested through the Federal Emergency Management Agency (FEMA) that a presidential disaster declaration be made.

Thursday, October 31st

JUAN finally left Louisiana and made landfall just west of Pensacola, Florida. The questions now were how much damage was done and what else could be done to facilitate interior drainage of flooded areas? The Corps had loaned 29 Crisafulli pumps to Terrebonne, Lafourche and Jefferson Parish officials to supplement their pumping efforts. Also, engineers from the Corps were at the various emergency sites to assist state and local emergency personnel with corrective actions. Reconnaissance surveys continued.

The water elevation in Orleans Parish had dropped significantly enough to allow the opening of Algiers lock and the floodgates along the Industrial Canal. The water elevation in Jefferson, Plaquemines, and St. Mary Parishes, though, had not dropped enough to allow the Harvey Canal lock nor floodgates in those parishes to be opened. However, tides were rapidly receding throughout the state.

Friday, November 1st

Having reviewed the damages in southern Louisiana and considered FEMA's recommendation, President Reagan declared a disaster area in three parishes (Jefferson, Lafourche, and Terrebonne) and was considering additional parishes after further review. The initial declaration was for private assistance only.

Tides had finally receded enough in Plaquemines and St. Mary Parishes to allow officials to open the Empire floodgate and the floodgates in the Berwick and Morgan City floodwalls. Harvey lock remained closed.

Saturday, November 2nd

Lafourche Parish officials requested that the NOD Commander allow them to make a 50-foot cut in the Larose to Golden Meadow hurricane protection levee (Section E-South, 1st lift), to facilitate interior drainage near Breton Canal east of Bayou Lafourche. This action was approved by the Commander; however, the cut and its later repair were accomplished as a modification to the existing government contract. Parish officials picked up Corps-furnished steel sheetpiles from Bayou Boeuf lock, and their contractor was setting up his rig so that pile driving at Bully Camp could commence on Sunday or Monday.

Sunday, November 3rd

The situation along Harvey Canal had improved and the lock was opened that morning. Also that morning, the Pointe Coupee Pumping Station was shut down when the water elevation was pumped down below +20.0 feet NGVD on the inside.

That afternoon, the Corps received reports from the LA OEP that a 100-foot section of the non-Federal Angola levee, above Baton Rouge, Louisiana, was damaged by heavy rains. The damage was repaired by state forces under the supervision of Louisiana Department of Transportation and Development (LA DOTD) personnel.

Monday, November 4th

No significant events occurred this date. Most of the day was spent assessing on-going and planned rehabilitation to damaged facilities. The Corps was directed by FEMA to consider Federal pumping assistance (supplemental assistance by contract) for Lafourche Parish. It was later determined that at the rate at which the tides were receding and internal drainage was occurring, additional assistance would not be required.

Tuesday, November 5th

In Lafourche Parish, pile driving operations were underway at Bully Camp, flow out of the Yankee Canal failure was marginal, and flow through the 50-foot cut near Breton Canal had stopped. Parish officials were using Corps-furnished Crisafulli pumps to pump out ponded water inside the protection system.

President Reagan added three more parishes (St. Bernard, St. Charles and St. John the Baptist) to the disaster declaration, for private assistance only. Damage to public facilities was still being assessed.

An inspection of the Bonnet Carre Spillway lower guide levee revealed minor erosion damage at the northern end of the levee system at Lake Pontchartrain. Damages were repaired by spillway personnel using available materials.

The Following Days

Engineers from the Corps, along with state, local and other Federal representatives, participated on the FEMA-coordinated Hazard Mitigation Team to determine what could be done to prevent similar damages from occurring in future events.

On November 8th, six more parishes or portions thereof (Plaquemines, Tangipahoa, St. Tammany, Livingston, Ascension, and the 9th Ward of Orleans) were added to the presidential disaster declaration, bringing the total number of parishes eligible for private assistance to 12. In late November, seven parishes (Jefferson, Terrebonne, Lafourche, St. Charles, Ascension, St. Bernard, and St. John the Baptist) were declared eligible for public assistance under PL93-288, which is administered by FEMA. Also on November 8th, NOD distributed a public notice advising state and local agencies of procedures to apply for PL84-99 assistance to rehabilitate flood control structures or federally authorized hurricane protection and beach erosion projects damaged by JUAN. Of eight applications received, only the Grand Isle Hurricane Protection and Beach Erosion Project qualified for assistance under PL84-99. The other applications for rehab of levees or dikes were denied because the damaged facilities were not designed and constructed to protect against riverine-related (headwater) flooding, and therefore did not qualify as a "flood control structure" as defined in the Flood Control Act, nor were they federally authorized hurricane protection or beach erosion projects. Most of those facilities were constructed for drainage or land reclamation purposes. Many of these damaged facilities were later repaired under PL93-288 (FEMA) or by a similar program administered by the Soils Conservation Service (SCS).

Just when it appeared that conditions were stabilized and recovery activities could slow down, another hurricane, KATE, had reached the Gulf of Mexico and was heading toward Louisiana. Fortunately for NOD and the residents of southern Louisiana, on November 20th, after approaching within 320 miles of New Orleans, KATE turned to the northeast and eventually made landfall near Panama City, Florida, the following day.

In early December, the Corps was tasked by FEMA to assist with disaster recovery efforts under PL93-288.

DAMAGES AND EMERGENCY ACTIVITIES

(FEDERALLY AUTHORIZED PROJECTS)

GRAND ISLE HURRICANE PROTECTION AND BEACH EROSION PROJECT.

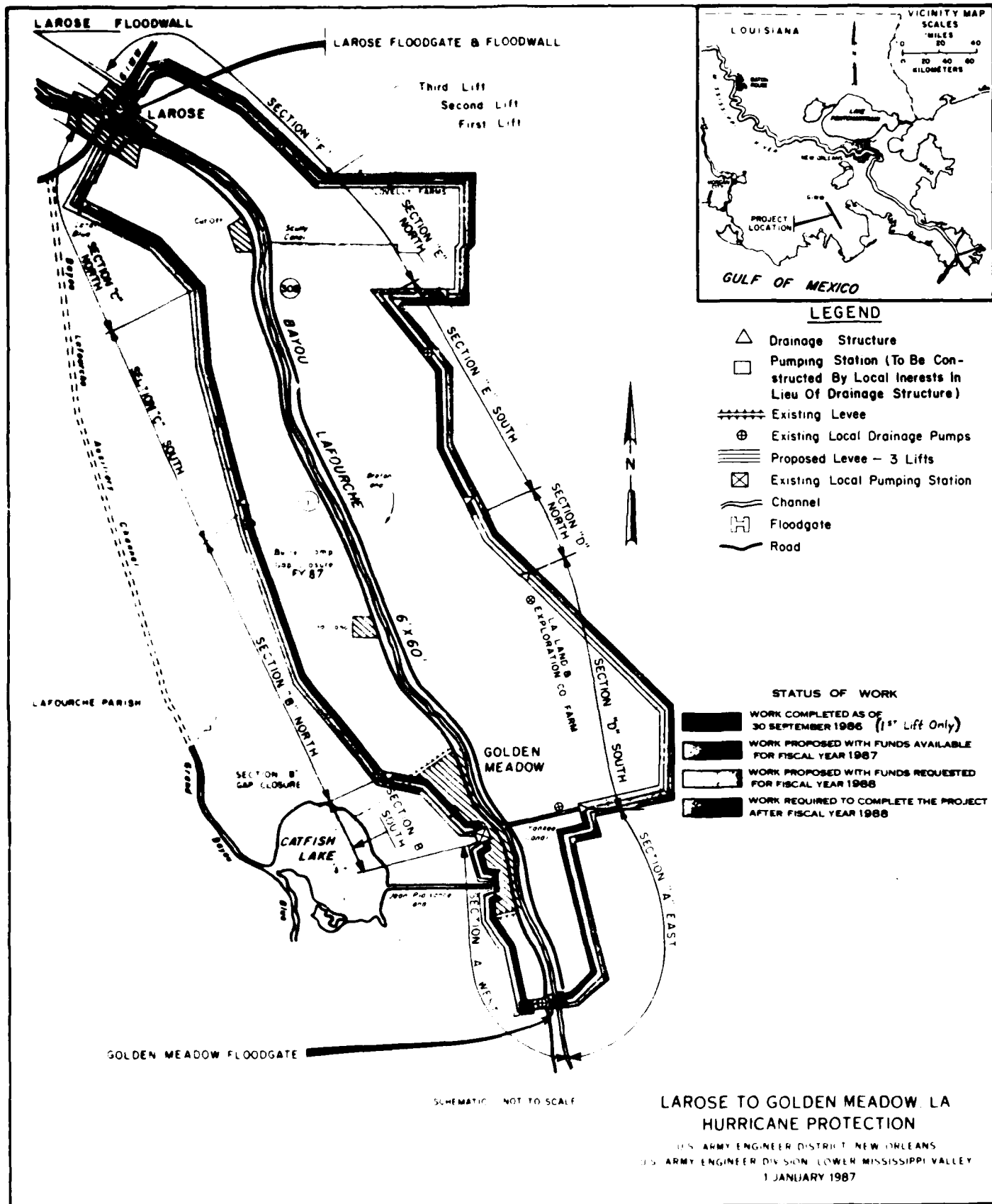
Grand Isle is a low-lying barrier island with natural ground elevations ranging from approximately 3 to 5 feet above NGVD. A manmade dune with a crest elevation of +7.0 feet NGVD was constructed in 1976 along the gulf shore of the island to replace the natural dune destroyed by Hurricane CARMEN in 1974. The dune was funded by FDAA, predecessor to FEMA, under the provisions of PL93-288. The present project was authorized under the authority of Section 201 of the PL89-298 by resolutions of the Senate and House Public Works Committees adopted 1 October and 23 September 1976, respectively. The present dune was authorized for construction to a crest elevation of +11.5 feet NGVD. The authorization also provided for a wave berm (beach) gulfward of the dune and a 2,600 foot jetty at the western end of the island. The dune and beach were designed to provide protection from gulf waves generated by hurricanes of a magnitude that recur with an average frequency of once in every 50 years. The project would provide no protection from still water flooding or from hurricane driven bay waves. Construction of the project began in 1983. Essential aspects of the dune and berm construction were completed in the summer of 1984. Total construction, including dune vegetation, was completed in late summer of 1985 at a cost of \$8,640,000; however, several areas of the project damaged by recent storms needed to be repaired. See explanation below.

In the winter of 1984/1985, the beach experienced damaging erosion due to winter storms in five areas totalling approximately 10,600 feet in length with the loss of approximately 230,000 cubic yards of sand. This comprised

approximately 25 % of the project length and roughly 8 percent of the total volume of sand placed during construction. The Corps and local assurers, the LA DOLB, were concerned by the isolated locations of the losses and were moving toward implementing corrective actions when Hurricane LANNY hit the area in mid-August 1985. LANNY caused the loss of 70,000 additional yards of sand from essentially the same five problem areas on the beach. In early September, Hurricane ALMA caused an additional loss of 40,000 yards of sand from the beach. With the passage of each storm, the damage to the five problem areas became worse and represented an increasing threat to the integrity of the yet undamaged dune. Realizing this, the Corps and LA DOLB were finalizing revised construction plans for corrective measures when Hurricane JUAN struck in late October. JUAN caused the loss of an additional 370,000 yards of sand, leveled the sand dune at two locations over a distance of 1,000 feet, did significant damage at other locations over a distance of 14,000 feet, and eroded much of the beach.

After careful engineering evaluation of the damages, NOL recommended that the project be restored to project design with improvements made at certain areas. The proposed rehabilitation includes (1) restoration of beach and dune to original design section, and restoration to original design of all ancillary features such as dune vegetation, emergency vehicle ramps, and pedestrian crossovers; (2) construction of 14,000 feet of dune; raising of the dune crown 2 feet for a length of 7,500 feet; raising of the dune crown 6 inches for a length of 7,000 feet; and (3) extension of the east and west jetties 180 feet each, and construction of 1,200 feet of segmented, offshore breakwater. Items (2) and (3) were not part of the original design.

The Secretary of the Army approved the restoration and improvements of the project using a combination of Civil Works Program authorities and funding. Damages caused by JUAN were



authorized for repair under PL84-99, while other work will be funded by either the Construction General appropriation or the project's maintenance authority. Costs incurred under PL84-99 will be 100% Federal (approximately \$2,250,000), and the other work will be cost-shared with local interests.

It is estimated that the structural damage prevented by this project ranged between 12-14 million dollars.

LAROSE TO GOLDEN MEADOW, LA, HURRICANE PROTECTION PROJECT.

The Larose to Golden Meadow project is located in Lafourche Parish and is only 50% complete. The project was authorized under the Flood Control Act of 1965, was approved in October 1965, and is designed to provide protection against a hurricane having a frequency of once in 100 years. Included in the project are approximately 40 miles of loop levee along both banks of Bayou Lafourche, enlargement of 3 miles of existing levee at Golden Meadow, two floodgates where the loop levee crosses the bayou at the upper and lower bayou crossings, 8 miles of low interior levees to regulate intercepted drainage, and seven proposed locally-constructed pumping stations, which will replace the originally authorized eight multibarreled culverts with flap gates through the levees.

As stated earlier, the project is partially complete. First lift levee construction was completed in Sections A West, A East, B North, B South, C South, F and the Gap in Section B; also, the Golden Meadow floodgate was operational when JUAN struck.

Because the project was incomplete, it was unable to fulfill its intended purpose. There were no failures in the partially completed portions of the project; however, there were two failures in locally constructed levees (Bully Camp and Yankee Canal) in gaps left in the Federal project. NOTE: The "gaps" in question were intentionally left in the project to allow local

interests access to the pump station construction sites. Had this project been completed and no failures occurred, thousands of homes and acres of agricultural land between Larose and Golden Meadow would have been protected; an estimated \$35 million in damages would have been prevented. The project is not expected to be 100% complete until the year 2000.

Although there were no failures in the project, in an effort to facilitate internal drainage on the east bank of Bayou Lafourche, the Corps approved a 50-foot cut in the Federal levee in Section E South, which was under construction (1st lift) near Breton Canal. A contract modification was let and the levee was repaired by the Corps' contractor using project funds.

OTHER FEDERAL HURRICANE PROTECTION PROJECTS.

Other Federal hurricane protection projects, including the Lake Pontchartrain Project in Jefferson Parish; Lake Pontchartrain and Vicinity Project in Orleans and St. Bernard Parishes; and the New Orleans to Venice, LA, Project in Plaquemines Parish, fulfilled their intended purpose, with no failures occurring and no significant damages reported on the protected side of the various projects.

Minor damage did occur on the protected side of the Lake Pontchartrain west return levee (Item A) behind the New Orleans International Airport. Levee district personnel discovered seepage on the levee berm and assumed that sand boils were occurring. However, an airport employee noticed the emergency work being performed and advised levee district officials that the seepage was occurring in an area where a permitted electrical conduit for airport runway lights had been installed through the levee several years ago. Examination of the conduit by divers in the adjacent Parish Line Canal revealed that the wax plug in the conduit had failed and water was flowing through joints or cracks in the conduit. The divers plugged the conduit and the seepage

stopped. Levee district personnel installed an earthen blanket over the levee slope and berm to restore the area to original condition. Two engineers from the Corps inspected the levee and determined that the levee was in satisfactory condition.

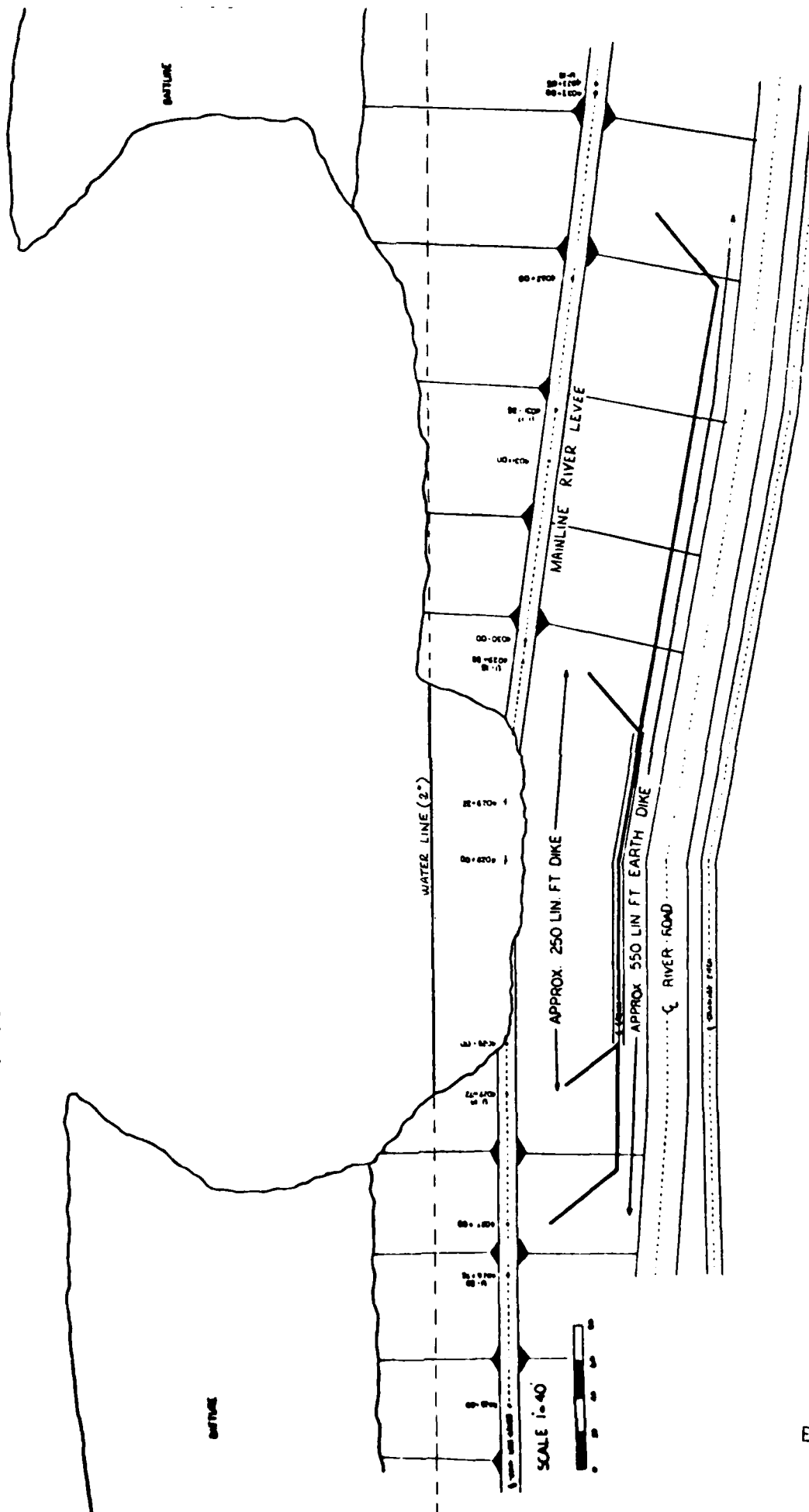
MISSISSIPPI RIVER AND TRIBUTARIES PROJECT.

Of particular concern to the Corps was the rehabilitation of a major bank and levee failure on the right descending Mississippi River bank, vicinity of river mile 100.5 AHP at Marrero, Louisiana, in Jefferson Parish (See Exhibit 4 on the next page). The failure, known as the Celotex Failure, occurred on July 30, 1985, and restoration work commenced on September 5th. The Corps' contractor, Anthony J. Bertucci Construction Company, was operating on an accelerated basis and by the time JUAN struck, the bank and most of the levee had been reconstructed. A contingency plan for protection against hurricane tidal surge at this site was prepared by NOD prior to Hurricane DANNY in mid August, but the river stage did not rise enough during any of the hurricanes to threaten the project. (See plan following this section)

Elsewhere, hurricane winds forced high tides to overtop a Federal flood control levee near Gordy Pumping Station in St. Mary Parish; however, no significant damage resulted from the overtopping. This flood control levee is part of the Mississippi River and Tributaries (MR&T) Project and is required for the operation of the Atchafalaya Floodway. The levee is not designed for hurricane protection and was also overtopped during Hurricane DANNY. Minor erosion damage to the Bonnet Carre Spillway lower guide levee was repaired by spillway personnel.

MISS. RIVER LEVEE FAILURE (AUG 85)
 RIGHT DESCENDING BANK AT MILE 100.2 AHP
 AT MARRERO, LA. IN JEFFERSON PARISH

MISSISSIPPI RIVER →

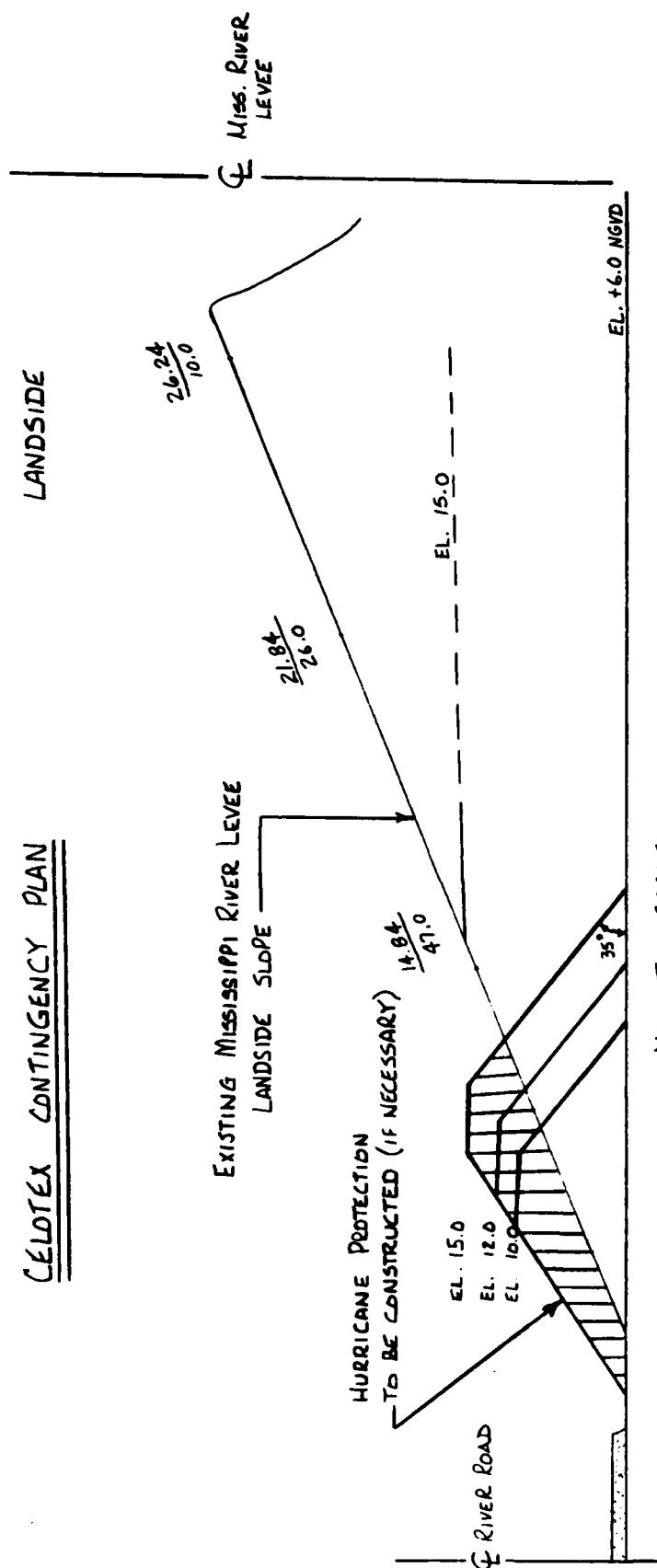


LMNOD-E

Marrero Levee Setback
Hurricane Protection Interim Plan
2 August 1985

1. No action is required at this time because stable protection exists to elevation 15.0 feet NGVD.
2. If the stability of the levee changes, a landside levee enlargement with elevation to be determined by existing river stage and storm intensity will be constructed by the West Jefferson Levee District. Maximum required protection is not expected to be above elevation 15.0 feet NGVD.
3. Levee Board Actions:
 - a. Monitor river stage daily.
 - b. Monitor weather bulletins regarding tropical storms and hurricanes.
 - c. Maintain capability to have levee board bulldozers and dragline on site within 4 hours.
 - d. Discuss temporary borrow of material from landside of river road with property owner adjacent to failure. This area will be part of the property appropriated for the levee setback.
4. Corps Actions:
 - a. Proceed with levee setback.
 - b. Maintain liaison with levee district regarding condition of levee, river stage, and tropical weather.
 - c. Provide on site technical assistance as required.

LANDSIDE



NOT TO SCALE

ESTIMATED QUANTITIES FOR APPROXIMATE 5' CROWN
SANDY MATERIAL ANGLE OF REPOSE 30° to 35°

STATION: 4029+00 RDB.

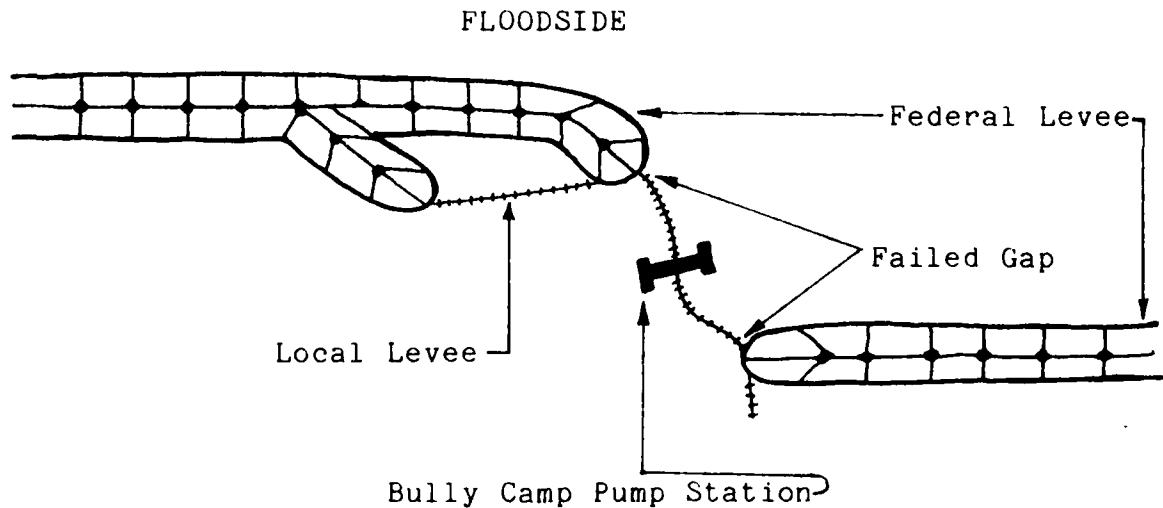
250 LIN. FEET		550 LIN. FEET
EL. 15.0	1000 YD ³	2100 YD ³
EL. 12.0	300 YD ³	700 YD ³
EL. 10.0	200 YD ³	350 YD ³

(NON-FEDERAL PROJECTS)

LAFOURCHE PARISH

BULLY CAMP LEVEE FAILURE.

Bully Camp is an area west of Bayou Lafourche below Cut Off, Louisiana, in Section C South of the Larose to Golden Meadow, La, Hurricane Protection Project. A gap was intentionally left in the Federal hurricane protection levee system during 1st lift construction to allow access to a local pumping station construction site. In the gap was a locally constructed levee and small pumping station, consisting of three 48-inch pumps (capacity: 35,000 GPM). See sketch below.



(Sketch 1)

On the afternoon of October 28th, having been saturated by high tides and heavy rainfall for several days, the local levee washed out. The pump station was partially submerged and one discharge line was destroyed. Water from outside the levee system rushed through the failed area and flooded land and houses between Bully Camp and Golden Meadow.

Lafourche Parish and South Lafourche Levee District personnel surveyed the situation and contacted the Corps of Engineers for technical advice on flood fighting the situation. Access to the site by land and water was difficult, and it would have taken too long to get large bucket dredges to the area. Because of the inaccessability of floating and land plant to this location, it was recognized that construction of any type of closure could not be completed in time to prevent or appreciably reduce flooding from the hurricane tide; however, a closure was necessary to remove ponded flood waters during the recovery phase. The second alternative was to close the gap with steel sheetpiling. When the Corps learned that the parish had issued a contract for a pile driving rig and was seeking to procure steel sheetpiles, NOD offered to loan the parish the necessary pilings from its surplus stockpile located at Bayou Boeuf lock in St. Mary Parish. NOTE: The Government - owned sheetpiles (type: BZ 350 width: 1.64 ft) were surplus materials procured during the 1973 Flood Fight, and had an estimated cost of \$6.50 per square foot of pile, based on current dollars. The Corps also sent two design engineers to the site to determine the design requirements for the closure. The Corps loaned the parish a total of 317 piles for the closure. driving commenced on November 4th and was not completed until November 19th. Estimated cost of repairs, which included 360 linear feet of sheetpiles, a shell roadway over the adjacent levee, 30 linear feet of bulkhead at the pump station suction, erosion repair of 250 linear feet of levee berm, replacement of the 48-inch discharge line, thousands of cubic yards of shell against the sheetpile wall, and other miscellaneous items, was \$443,700. Estimated value of the sheetpiles was \$168,000. As expected, the outside tide levels receded before completion of the closure and some of the landside flooding actually drained out through the levee breach.

YANKEE CANAL LEVEE FAILURE.

Yankee Canal is located on the eastern side of Bayou Lafourche across from Golden Meadow, and is the divider between Sections D and A East of the Larose to Golden Meadow project. The failure occurred in a gap similar to the one at Bully Camp, but was not as severe as that failure. Flow through the failed area flooded land and homes east of Bayou Lafourche. A contract dredge was sent to the site by the parish and a closure was made after tides had receded and flow through the gap had stopped. Estimated cost of repairs was \$32,600.

INCOMPLETED PORTIONS OF LAROSE TO GOLDEN MEADOW PROJECT.

Heavy rain and high tides remained in this area for so long that eventually high water migrated to the northern portion of the project near Larose, and entered the system where no Federal levees have been constructed to date. As a result of this and the above referenced failures, approximately 90% of the area inside the project was flooded. As tides receded, the Golden Meadow floodgate was opened to allow internal drainage. The Corps loaned the parish and levee district 19 Crisafulli pumps to assist their efforts with internal drainage. Had the Larose to Golden Meadow project been completed and no failures occurred, an estimated \$35 million in damages would have been prevented.

JEFFERSON PARISH

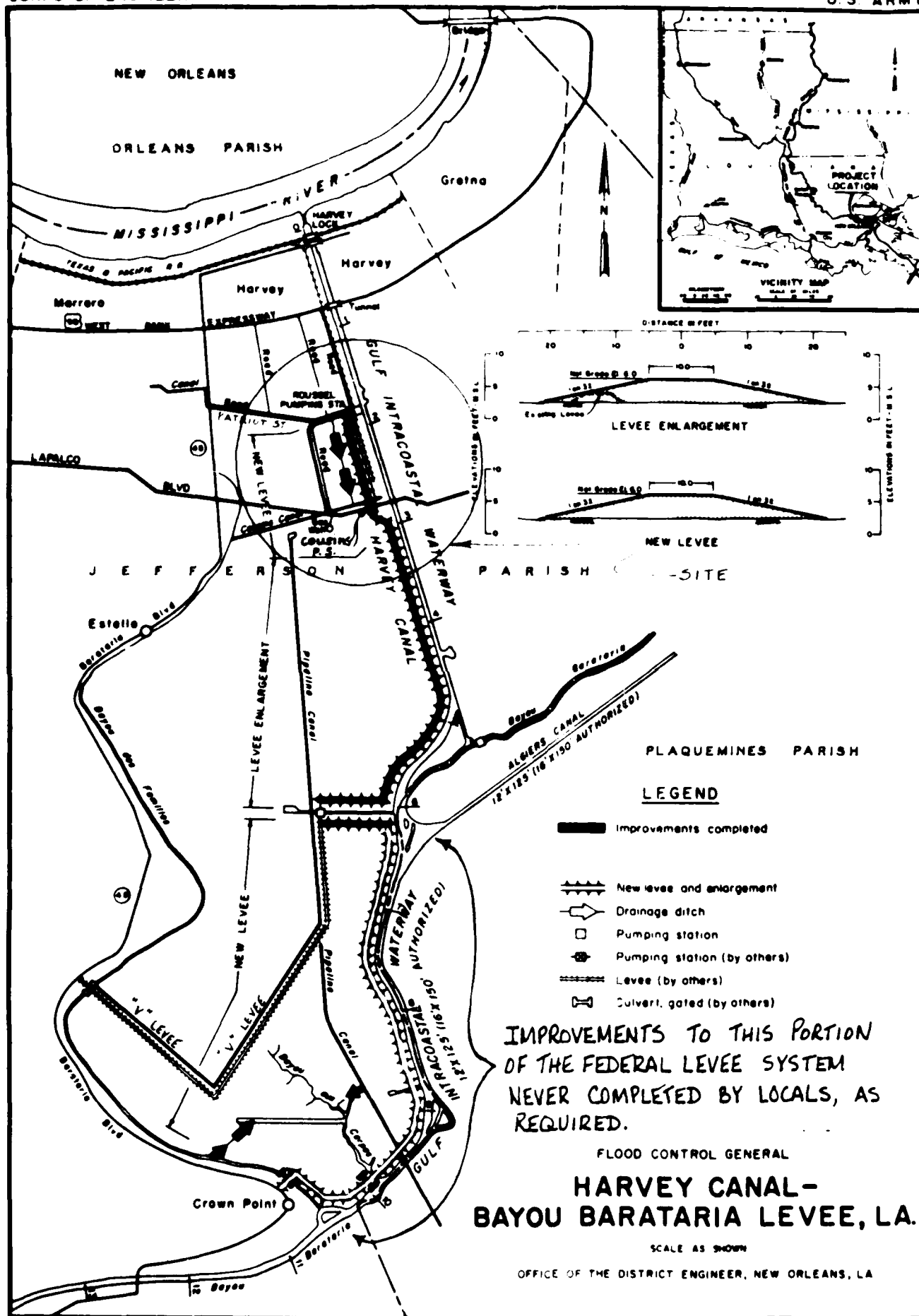
FLOODING ALONG HARVEY CANAL.

Harvey Canal is located west of the Mississippi River in Jefferson Parish and is part of the Gulf Intracoastal Waterway (GIWW). Along the west bank of the canal is the federally constructed Harvey Canal - Bayou Barataria Levee, which extends from the Roussel Pumping Station near canal mile 1.8 to Crown Point, Louisiana, near mile 10.5. The levee was to be constructed in two phases: Phase I was levee construction by the

Corps, Phase II was levee shaping and gated culverts by local interests. Phase I construction by the Corps between the pumping station and Crown Point was completed in June 1973. Phase II construction by Jefferson Parish was never completed, due to insufficient parish funds; only that portion of the levee between Roussel Pumping Station and Estelle Pumping Station was fully completed. The purpose of the levee is to protect land adjacent to the canal and bayou from hurricane flooding.

The average water elevation in Harvey Canal is 0.1 feet NGVD and the maximum stage recorded prior to JUAN was 4.2 feet NGVD, which occurred during Hurricane CARLA in September 1961. At the top of the levee system at Patriot Street, the Harvey Pumping Station was under construction by local interests; however, at the time JUAN struck, the contract was in default and the site was abandoned. The only protection at the site was a partially completed floodwall and a small levee that tied into the Federal levee system.

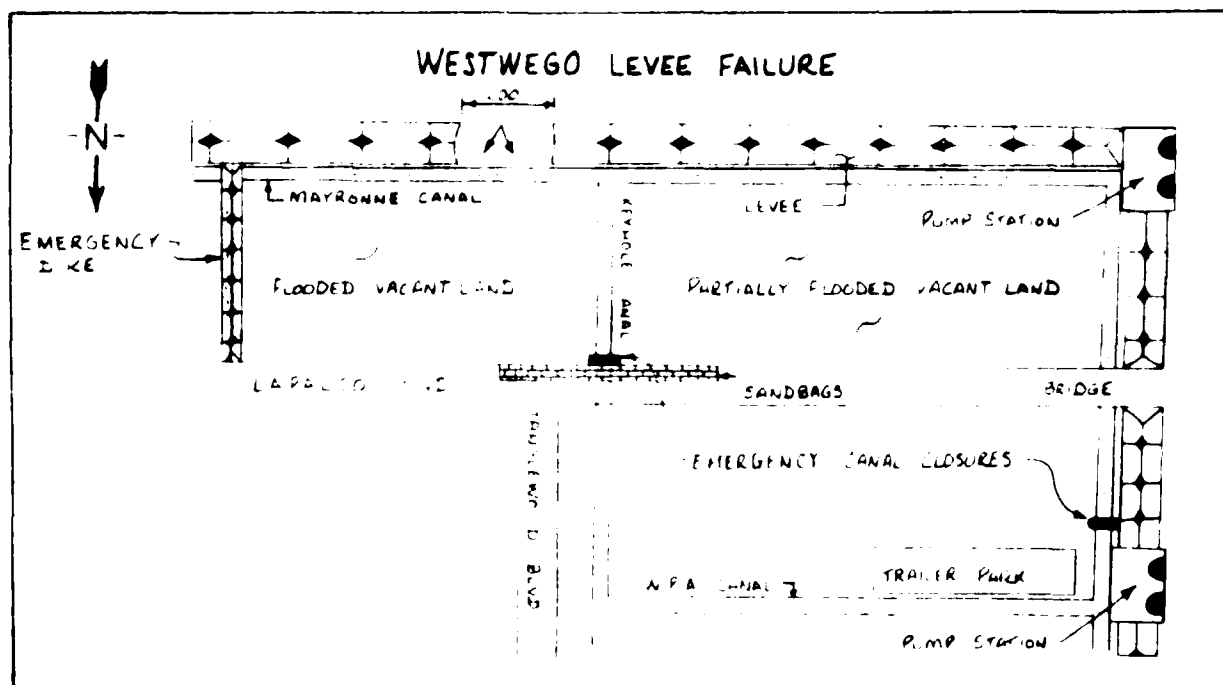
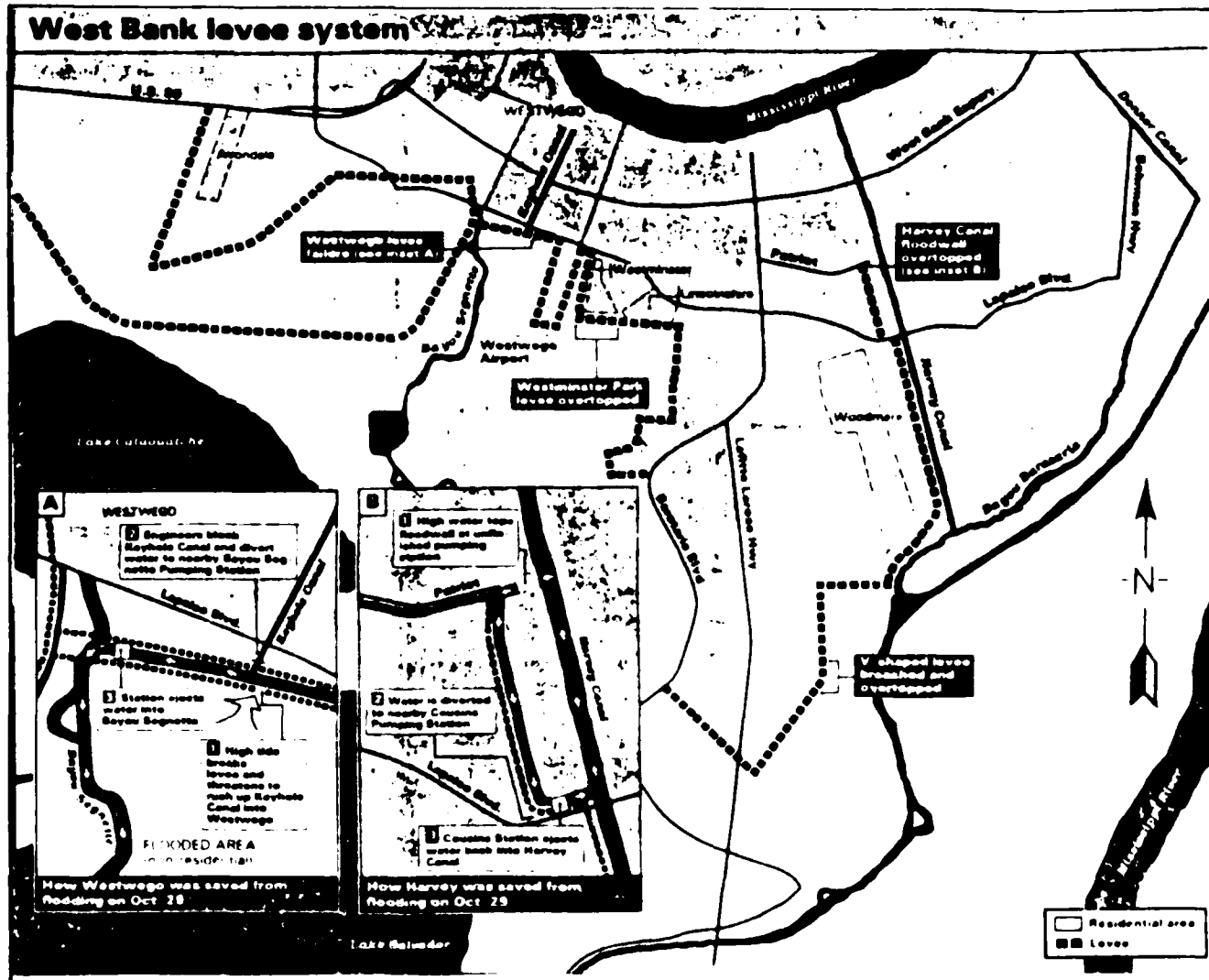
On Tuesday, October 29th, record high water elevations (4.74 feet NGVD) in the canal exceeded the banks and flowed around the incompleted floodwall and breached the small levee, flooding the immediate area. Fortunately, quick action by the West Jefferson Levee District and numerous volunteers prevented any residential neighborhoods from flooding. Levee district personnel and volunteers strategically placed sandbags and large concrete cylinders to divert the water to the nearby Cousins Pumping Station, where it was pumped back into Harvey Canal. The levee district requested that an engineer from the Corps meet with their consultant to review the district's actions. It was determined that the emergency actions taken were appropriate, and no residential flooding or damage to the Federal levee system resulted from this problem. See insert B in the sketch entitled "West Bank levee system".



WESTWEGO LEVEE FAILURE.

The Westwego Levee is located on the west bank of the Mississippi River at Westwego, Louisiana, in Jefferson Parish, and extends from the Westwego Pumping Station to the Westminster Levee (see sketch entitled "West Bank levee system"). The purpose of the levee is to protect developed areas of Westwego from backwater flooding from adjacent marshland. The levee is not a federally authorized hurricane protection project.

On Tuesday night, October 29th, high tides began overtopping the levee and eventually breached a 200-foot section of levee near Keyhole Canal. Flow through the gap flooded vacant land south of Lapalco Boulevard and threatened nearby residential neighborhoods. The Mayor of Westwego requested assistance from the West Jefferson Levee District, but their personnel were occupied with the flooding along Harvey Canal and were unable to lend assistance at the Westwego failure. The Mayor then called the Corps' Emergency Operations Center (EOC) and requested Corps assistance with emergency action plans. An engineer from the Corps was immediately dispatched to the site to provide technical assistance for plan development. The emergency plan included construction of an earthen dike east of the failure, between the levee and Lapalco Boulevard, and closure of two adjacent canals at key locations. This action successfully diverted the flow to the Bayou Segnette Pumping Station, where it was pumped back into the marshland. (See insert A on the sketch entitled "West Bank levee system" and detail on following page). In late November, while the 200-foot section of levee was being restored with Corps-furnished sheetpiles, an additional 400 linear feet of levee sloughed off immediately adjacent to the breach. The entire section was restored using Corps-furnished sheet piles from the Corps' surplus stockpile at Bayou Boeuf lock. The Corps loaned 400 sheetpiles (type: BZ350) for the repairs, which cost approximately \$121,200. The estimated value of the sheet piles was \$170,560, based on current dollars. The work was performed under the supervision of the West Jefferson Levee District and LA DOTD.



WESTMINSTER - LINCOLNSHIRE SUBDIVISIONS FLOODING.

The Westminster and Lincolnshire subdivisions are located adjacent to the Westminster Levee, which is located between the Westwego and Orleans Village levees (see sketch entitled "West Bank levee system"). This levee was constructed by the developer of the subdivisions to protect the area from backwater and coastal tide flooding from adjacent marshland. The levee is not a federally authorized hurricane protection project.

On October 29th, high tides overtopped the levee and flooded hundreds of homes in both subdivisions. Residents were forced to evacuate as 3 to 4 feet of water flooded their homes. An adjacent levee was later cut to facilitate internal drainage. There was no Corps assistance requested for this problem.

V-LINE LEVEE FAILURE.

The V-Line Levee, better known as the "V" levee, is located north of Crown Point, and extends from the Estelle Pumping Station to Barataria Boulevard (see sketch entitled "West Bank levee system"). The purpose of the levee is to protect developed areas north of the system from backwater and coastal tide flooding from adjacent marshland. The levee is not a federally authorized hurricane protection project.

On Wednesday, October 30th, local interests discovered that tides were overtopping a 300-foot section of the levee along the north-south stretch of levee some 4000 feet south of the Estelle Pumping Station. The water overtopping the levee posed no immediate threat to residential areas as flow was contained in the adjacent Pipeline Canal. Later that night, however, a 50-foot section of levee north of the overtopping section breached and allowed excessive flow through the gap. An engineer from the Corps was immediately dispatched to the site to provide

technical assistance with flood fighting techniques and emergency action plans. Flooding was confined to marshland but was gradually migrating northward toward residential neighborhoods. West Jefferson Levee District personnel and numerous volunteers placed sandbags on the 300-foot section of levee to prevent overtopping, and the levee district's consultant recommended that they construct a ring levee to restrict flow through the 50-foot gap until tides receded and permanent repairs could be made. The Corps of Engineers and LA DOTD concurred with this recommendation and advised the district to proceed immediately. The ring levee was constructed and flooding to residential areas was avoided. The breach was later repaired using Corps-furnished sheetpiles, which had an estimated value of \$20,000. The estimated cost of emergency activities and repairs exceeded \$100,000.

FEDERALLY AUTHORIZED HURRICANE PROTECTION ON THE WEST BANK IN JEFFERSON PARISH.

Severe damage occurred in Jefferson Parish on the west bank of the Mississippi River in areas where the Corps had proposed the West Bank Hurricane Protection Levee System many years ago. Had the levees been constructed, millions of dollars in damages and emergency measures may have been prevented.

The original West Bank Hurricane Protection Study was authorized in November 1965, but the project (levee construction) was delayed for several years due to lingering problems with Environmental Impact Statements (EIS), the National Park Service, and the selection of an acceptable levee alignment by the Jefferson Parish Council from 15 Corps-proposed alternatives. In September 1979, the Corps forwarded another proposed levee alignment to the parish council. The council considered the proposal and decided that they would pursue a different project for hurricane protection without Federal participation. As a result of that decision, in 1981 the Corps suspended the Federal study indefinitely.

In June 1984, after several denials of parish-proposed levee alignments because of encroachments on wetlands, the Corps forwarded a permit to the Jefferson Parish Council with an approved levee alignment. The approved levee alignment, known as the Modified E Alignment, was a Corps modification to the Alternative "E" alignment proposed by the Parish. The parish council did not accept the permit with the modified alignment. Therefore, a levee was never constructed on the west bank and the residents had to rely on the back levees for hurricane protection. The back levees were constructed by the parish and subdivision developers to protect the developed areas from backwater and coastal tide flooding from adjacent marshlands.

Following JUAN, the Corps was requested by parish and state officials to reactivate the West Bank Hurricane Protection Study. In 1986, funds were authorized for the feasibility study of a new Federal hurricane protection project titled "Hurricane Protection, West Bank of the Mississippi River, Vicinity of New Orleans." This study is being given the highest priority in the District. At the time of this writing, the feasibility report on the project was being reviewed by higher headquarters, and it is anticipated that the project will be approved in February or March 1987.

(ADDITIONAL DAMAGES REPORTED)

Thousands of acres of agricultural and pasture land throughout all southeastern Louisiana parishes were flooded by high tides causing nearly \$200 million in losses to crops (primarily soybeans, sugar cane and rice) and livestock. Several thousand cattle and other livestock drowned in the flooded fields; others were stranded on high ground and survived on hay dropped from helicopters by National Guardsmen. Additionally, the crawfish industry sustained a \$2 million loss as a result of the flooding.

LAFOURCHE PARISH

There were several non-Federal levees damaged by JUAN in addition to those previously mentioned, including the Golden Meadow protection levee, the Flootation Canal levee at Fouchen, the Morvant Pumping Station levee, the Bayou Blue levee adjacent to Edna Pumping Station, the 40 Arpent levee (west) and Claudet levee at Lockport, the Mobly/Serigny levee below Golden Meadow, the levee west of Pie-Theriot floodgate, the T-Blue levee near Cut Off, the Bourg-Larose Pumping Station levee, the Delta-Clovelly-Barker levee east of Bayou Lafourche, the Lockport back levee, the Chackbay levee, and the Breton Canal levee.

The Golden Meadow Pumping Station received some mechanical damage and major electrical damage as a result of the station being inundated with salt water.

In addition to structural damages sustained within the parish, numerous drainage ditches and Belle Pass had to be dredged to remove silt deposits caused by the rise and fall of the tide.

JEFFERSON PARISH

There were several locally constructed pumping stations and adjacent levees that were significantly damaged during Hurricane JUAN. Damages included erosion around the wing-wall and levee of the Estelle and Bayou Segnette Pumping Stations, the trash screens at the Estelle and New Ames stations, serious erosion beneath the Hero Pumping Station, erosion of several thousand feet of levee adjacent to the Estelle and Bayou Segnette stations, shifting of discharge pipe support pilings at the Bayou Segnette station, and the mechanical rakes, vertical pump No. 2, and horizontal pump No. 3 at the New Ames station.

Additionally, there were siltation problems at the Kenner Boat Launch, flooding of homes and other property at Lafitte, Louisiana, and erosion of a small back levee on the north side of Grand Isle.

TERREBONNE PARISH

In addition to substantial agricultural and livestock losses, there were hundreds of breaches in levees (dikes) surrounding the agricultural land. The agricultural levees in Terrebonne Parish were restored under authorities administered by the Soils Conservation Service (SCS). Some of the levees restored by SCS were the upper Montegut levee, the 4-8 levee near Humble Canal, the Bayou Lacache levee, the Carlburg levee, the Bayou Plat levee, and the lower Dularge levee.

Also, there were two pumping stations, Montegut and Boudreaux Canal stations, that received significant damage both mechanically and electrically when they were submerged in salt water. These stations were restored under PL93-288, administered by FEMA.

ST. BERNARD PARISH

Damages in this parish were to those unprotected areas outside the Federal hurricane protection system; mainly, in the towns of Ysclosky, Alluvial City, Hopedale, Delacroix, Florissant, Woodlake, and Shell Beach.

There was salt water damage to the Woodlake Pumping Station, significant erosion and breaches in local back levees, a caved bank along Bayou Terre Au Boeufs at the Regio Canal, and two flapgates were knocked off culverts at the Kenilworth water control structure.

ST. CHARLES PARISH

On the east bank of the Mississippi River, several pumping stations sustained damage to electrical systems, mechanical parts, and some structural parts. The stations included Ama, Ormond, Turtle Pond, George Cousins, and New Sarpy. There were levee and bank failures adjacent to the Norco Pumping Station on the east bank and the Willowdale Pumping Station on the west bank. Along the Lake Pontchartrain shoreline at the Inesco Canal, considerable erosion had occurred and a shell dike had washed out. There was extensive street flooding and some residential flooding in parts of New Sarpy, St. Rose and Almedia on the east bank and in Des Allemands, Luling and Bayou Gauche on the west bank, where pumping capabilities were either inadequate or non-existent.

ST. JOHN THE BAPTIST PARISH

There was extensive street flooding on both sides of the river. Approximately 100 homes on the east bank and 40 homes on the west bank were flooded. There was minor erosion damage to dikes behind Homewood, Laplace Park and Belle Point Subdivisions.

ASCENSION PARISH

There was minor flooding reported in the towns of Sorrento, St. Amant and Acy. A bank failure along Muddy Creek Bayou restricted drainage from upstream areas and the spoil dike along New River Canal was washed back into the canal, thereby reducing the carrying capacity of these drainage channels. The parish was in the process of dredging the New River Canal to enlarge the channel depth and width when JUAN struck. It was the newly dredged material that was washed back into the canal.

OTHER SOUTHERN LOUISIANA PARISHES

Other parishes, including Livingston, St. James, St. Tammany, St. Mary, St. Martin, St. Landry, Tangipahoa, Plaquemines, Vermilion, Iberia, Evangeline, Jefferson Davis, Acadia, and Lafayette, reported areas of isolated flooding from high tides and heavy rainfall. Some residential flooding was reported, but most flooding was to roads and low-lying agricultural lands.

**CORPS ASSISTANCE TO FEMA
RECOVERY EFFORTS UNDER PL93-288**

Declaration Date: November 1, 1985

Agreement No. : FEMA 752-DR

Incident Period: 27 Oct - 8 Nov

Type Assistance: Public Assistance - Categories A, B, D, & G

FEMA Officials: Bob Broussard, Federal Coordinating Officer
Lonnie Chant, Public Assistance Officer
Greg Solovey, Assistant PAO

Cost Sharing % for Rehab: Federal 75.0 %
State 12.5 %
Local 12.5 %

Corps Participants:

Corps Coordination & Review of DSRs:	Don Clement	- Emergency Manager
	Jerry Colletti	- Natural Disaster Manager
	Colette Duffour	- EOC Coordinator
	Dennis Duhon	- FEMA Coordinator

Parish Assistance:	Dennis Duhon	- Ops	Jefferson Parish
	Colette Duffour	- Ops	Jefferson Parish
	Lionel Gele	- NORO	Jefferson Parish
	Mike Sanchez	- Engr	Jefferson Parish
	Jim Richardson	- Engr	Jefferson Parish
	Andy Studdard	- Engr	Jefferson Parish
	Al Betancourt	- Ops	Ascension Parish
	Bert Duplantis	- Ops	St. Bernard Parish
	John Morton	- NORO	Lafourche Parish
	Tom Podany	- Plng	Terrebonne Parish
	Larry Brotherton	- Engr	St. Charles Parish
	Larry Dressler	- Engr	St. John Parish

Hazard Mitigation Team:	Tom Podany	- Plng
	Edil Rosas	- Engr

In early November, FEMA established their disaster field office (DFO) in the Federal Building in Houma, Louisiana, and operated from there until the recovery operations were completed in January 1986. Public disaster assistance and recovery efforts under PL93-288 did not commence until December 4th. Parishes eligible for public assistance included Jefferson, Lafourche, Terrebonne, Ascension, St. Charles, St. Bernard and St. John the Baptist. Damages covered within these parishes have been described in previous sections of this report.

The Corps' New Orleans District was tasked by FEMA to assist them in Categories A, B, D and G of PL93-288. Category A, DEBRIS CLEARANCE, included clearance of submerged materials deposited in drainage canals and navigable waterways as a result of bank or levee failures or intentional placement to block a canal. "Materials" were considered by FEMA to be any non-floating material other than filled sandbags, such as rock, riprap, soil, weighted cannisters, etc. (NOTE: Claims for sandbags and related activities were evaluated and processed by FEMA reservists in Category B). Category B, EMERGENCY MEASURES, included all temporary work, including labor, equipment and cost of materials, associated with the placement and removal of emergency materials other than sandbags. This covered placement and removal of earthen dikes, rock dikes, concrete cylinders, raising of existing levees and dikes, etc. Category D, WATER CONTROL FACILITIES, included all permanent structural rehabilitation of damaged levees, dikes, pumping stations, and other drainage facilities. Category G, WORK UNDER CONSTRUCTION, included repair or restoration of public facilities under construction. Work in this category included dredging a drainage canal and restoration of an adjacent spoil dike at a canal in Ascension Parish where similar work was being performed when JUAN struck, and restoration of a local pumping station construction site in Jefferson Parish that was abandoned due to contract default.

There were 15 Corps employees assigned to assist FEMA with the recovery activities. Parish assistance team members were activated on December 4th and operated 11 hours per day Monday through Saturday. Each team consisted of a Federal, state and local representative (inspector), with the Federal member being the lead member of each team. The teams inspected each damaged facility and evaluated all emergency measures prior to preparing a recommendation to FEMA. Recommendations were made through the preparation of damage survey reports (DSRs). Each DSR included the location and description of damages or emergency measures taken, the plan for rehabilitation, the estimated cost of restoration, supporting data (photographs, drawings, records, receipts, etc.), and the eligibility recommendation. It was the responsibility of the assistance teams to determine the most efficient and economical method of restoring the damaged facility to pre-disaster condition, even if it meant replacing the facility or portions thereof. It was, as always, the responsibility of the Federal representative to prepare each DSR based on the information he/she gathered during the inspection and that which was provided by the state and local representatives. It should be noted that preparation of DSRs following Hurricane JUAN was somewhat more difficult and tedious than usual. This could be attributed to the extensive time period between the Presidential declaration date (1 November) and the public assistance initiation date (4 December), which allowed for state and local agencies to restore damaged facilities and remove emergency measures prior to the inspections. From that point, without knowledge of pre-disaster condition of the facility and with generally poor record keeping by claimants, it was difficult for the inspectors to accurately determine what was actually done and what was necessary to restore the facilities without improving them. All records had to be thoroughly examined to verify expenditures and eliminate duplications. DSRs prepared by Corps representatives were further reviewed by a Federal reviewer in the NGB Emergency Management Section prior to

the report being submitted to FEMA. (FEMA is responsible for making the final reimbursement decision).

The Corps also participated in the Interagency Hazard Mitigation Program. Two engineers from NOD participated on the Hazard Mitigation Team, which was assigned to determine what immediate changes could be made in policies, practices, and field conditions to prevent similar occurrences and damages from future storms. A 3-day study was made and recommendations were consolidated by FEMA. The final report titled "Interagency Post-Flood Recovery Progress Report" was published by FEMA on April 4, 1986.

HURRICANE DANNY
August 13-16, 1985

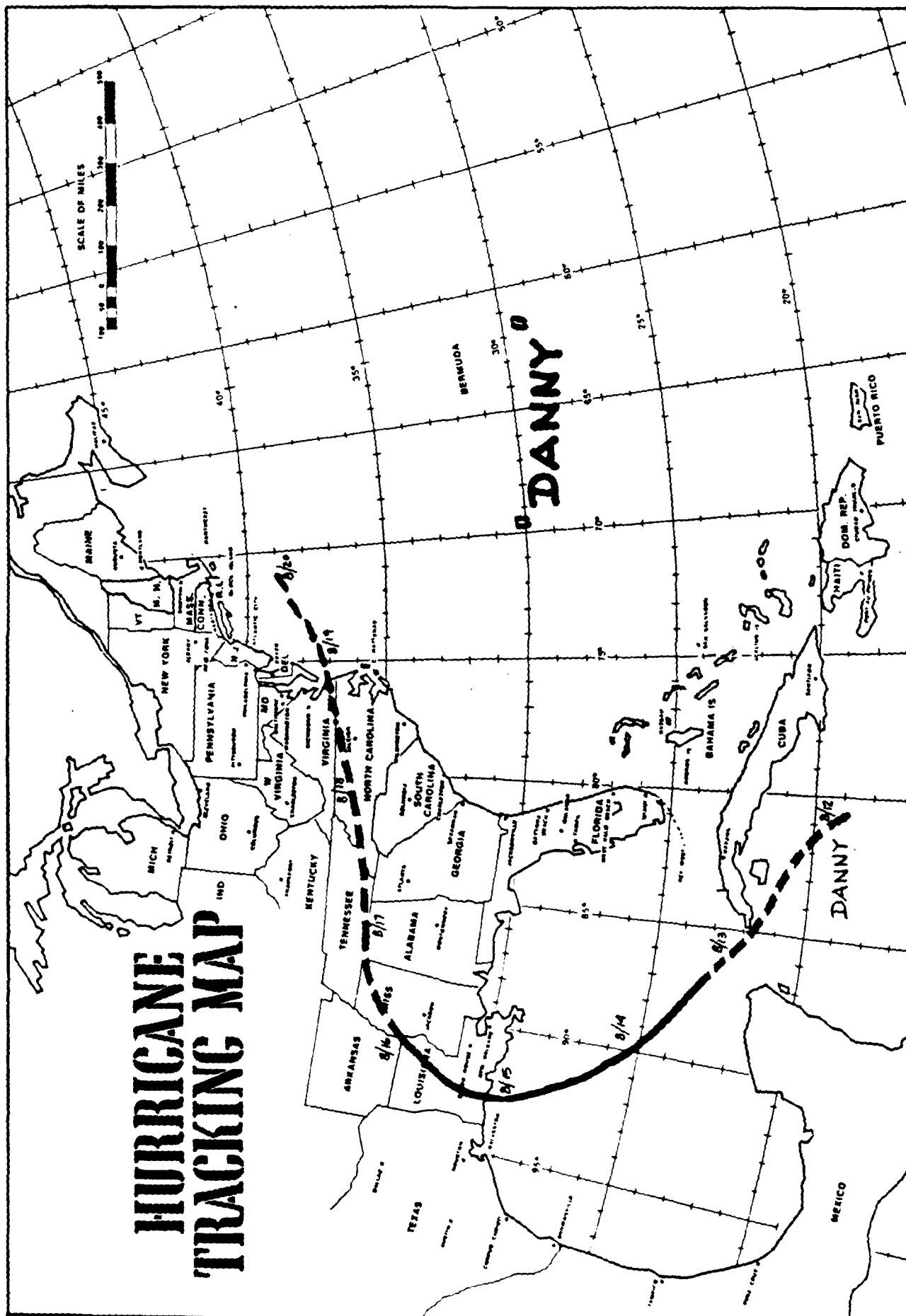
Danny formed from a tropical depression in the northern Caribbean and was upgraded to a tropical storm soon after entering the Gulf of Mexico on August 13, 1986. The following day, Danny was declared a hurricane and a hurricane warning was placed in effect between Freeport, Texas and the Mississippi River. Danny's forward speed was quick (10-15 MPH) and its path was direct. At approximately 11:00 A.M. on August 15th, Danny crossed the Louisiana coast 55 miles south of Lake Charles, Louisiana, in the vicinity of Pecan Island in Vermilion Parish. Shortly after Danny made landfall, it was downgraded to a tropical storm.

Danny was a Category 1 hurricane with maximum winds of 85 MPH. Despite the fact that there were 39 tornadoes associated with Hurricane Danny and its remnants as the storm moved through the southeastern United States, Danny's wind damage was minimal and the primary effects were in the form of flooding from localized heavy rains and high tides. There were no deaths attributed to Danny.

Reports from the LA OEP indicated that Danny damaged approximately 38,000 acres of crops in southwestern Louisiana, valued at \$10 to \$13 million. Flood and wind damage to private and public facilities was estimated at \$7 to \$10 million. There was no significant damage to any Corps facilities or structures within NOD. Of particular concern was the Celotex levee failure, a major bank failure that occurred on the Mississippi River's right descending bank in Marrero, Louisiana, on July 30, 1985. A Hurricane Protection Interim Plan involving a landside levee enlargement was prepared, but no action was required. The levee remained stable and provided a sufficient amount of protection during the storm.

As a matter of record, the Bayou Bienvenue and Bayou Dupre control structures, the Empire Floodgate, and floodgates in the Berwick and Morgan City floodwalls were all closed during the storm. At Morgan City floodwall construction sites, the level of protection was raised to elevation +9.0 feet NGVD using sandbags.

HURRICANE TRACKING MAP



HURRICANE ELENA

August 28 - September 4, 1985

ELENA formed from a tropical disturbance in the Atlantic Ocean, passed over Cuba, and rapidly intensified entering the Gulf of Mexico, reaching hurricane status on August 29th. As the storm headed northwest toward the Louisiana coast at 20 MPH with 75 MPH winds, it unexpectedly slowed and turned east toward the Florida Peninsula. The storm threatened the Gulf coast for nearly 2 days, sending in damaging waves and winds. After making a clockwise loop off the Florida coast, ELENA sped westward and made landfall near Gulfport, Mississippi, on September 2nd. ELENA moved rapidly through Mississippi and parts of Louisiana and on up to Missouri, where the storm finally dissipated on September 4th.

ELENA was a Category 3 hurricane with maximum sustained winds of 127 MPH; minimum pressure recorded was 951mb. According to NOAA, the heaviest damage from ELENA's winds occurred between Bogalusa and Franklinton, Louisiana, in Washington Parish. Minimal damage was reported in neighboring St. Tammany and Tangipahoa Parishes within the New Orleans District. There was no damage reported at any Corps facilities within NOD. Overall, the total uninsured public and private losses were \$3 million and the Insurance Institute reported \$13.8 million in private losses. There was approximately \$500,000 in agricultural losses (mostly timber). Hurricane ELENA caused more than \$2.5 million in damage in Louisiana; however, that was not enough to justify Federal disaster assistance under PL93-288. There were no deaths reported in Louisiana resulting from Hurricane ELENA.

As a matter of record, the Orleans Levee District was required to close all gates in the IHNC floodwalls. Additionally, the Empire floodgate in Plaquemines Parish and the Bayou Bienvenue and Bayou Dupre control structures in Orleans and

St. Bernard Parishes, respectively, were closed by the levee districts due to high tides. Because of the course ELENA was heading after making the clockwise loop off the Florida peninsula, large portions of St. Bernard, St. Tammany, Tangipahoa, and Washington Parishes were evacuated; also, evacuations were recommended by local officials for the extreme eastern portion of Orleans Parish and part of Kenner in Jefferson Parish.

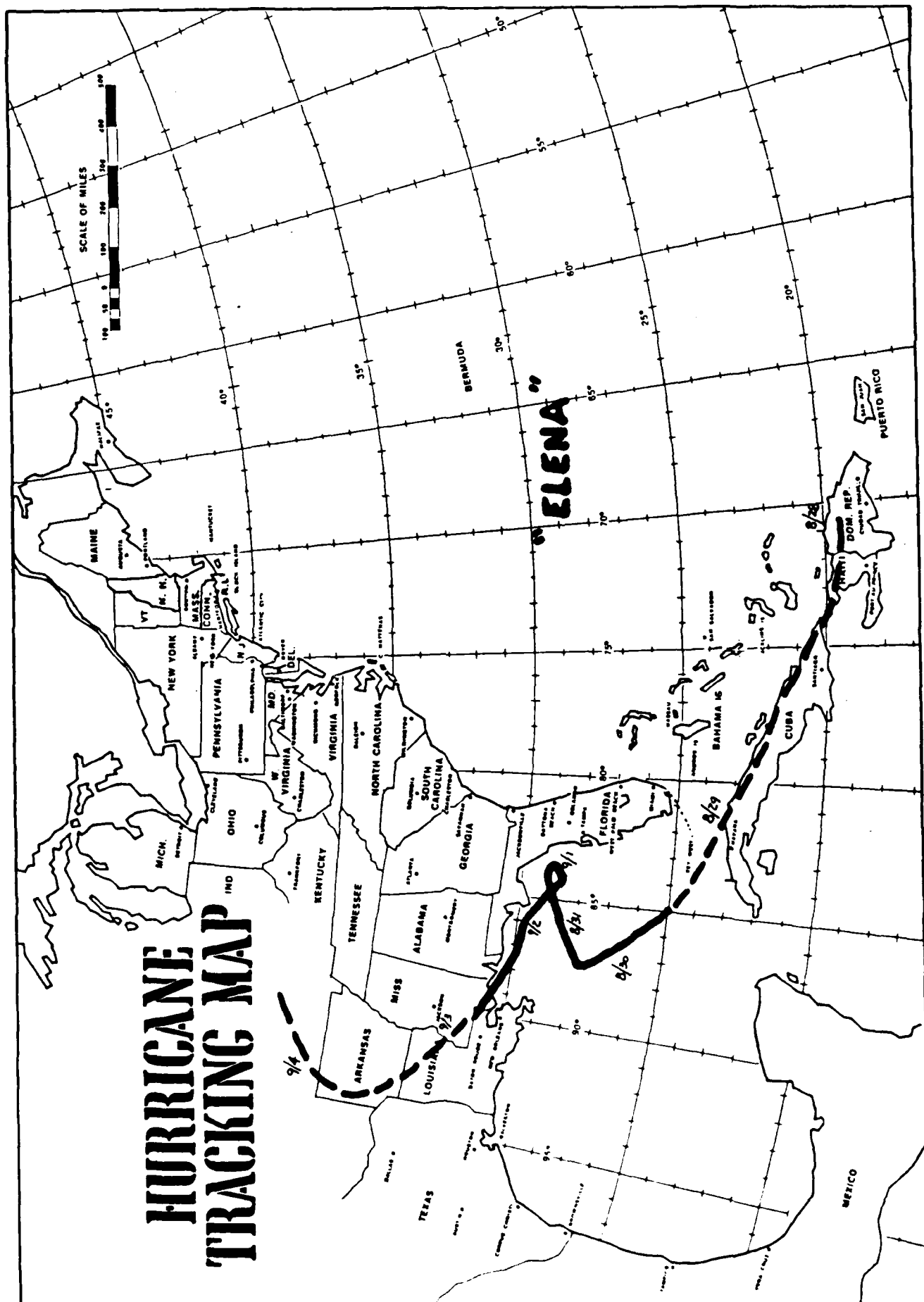
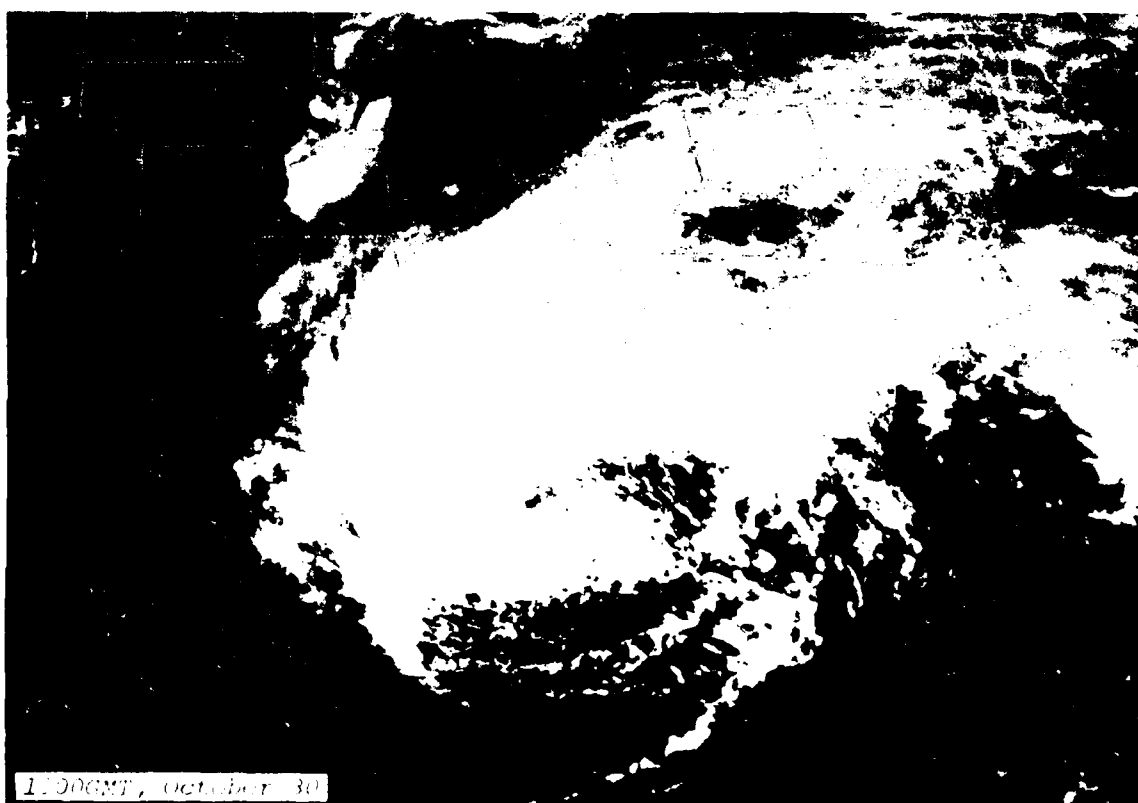
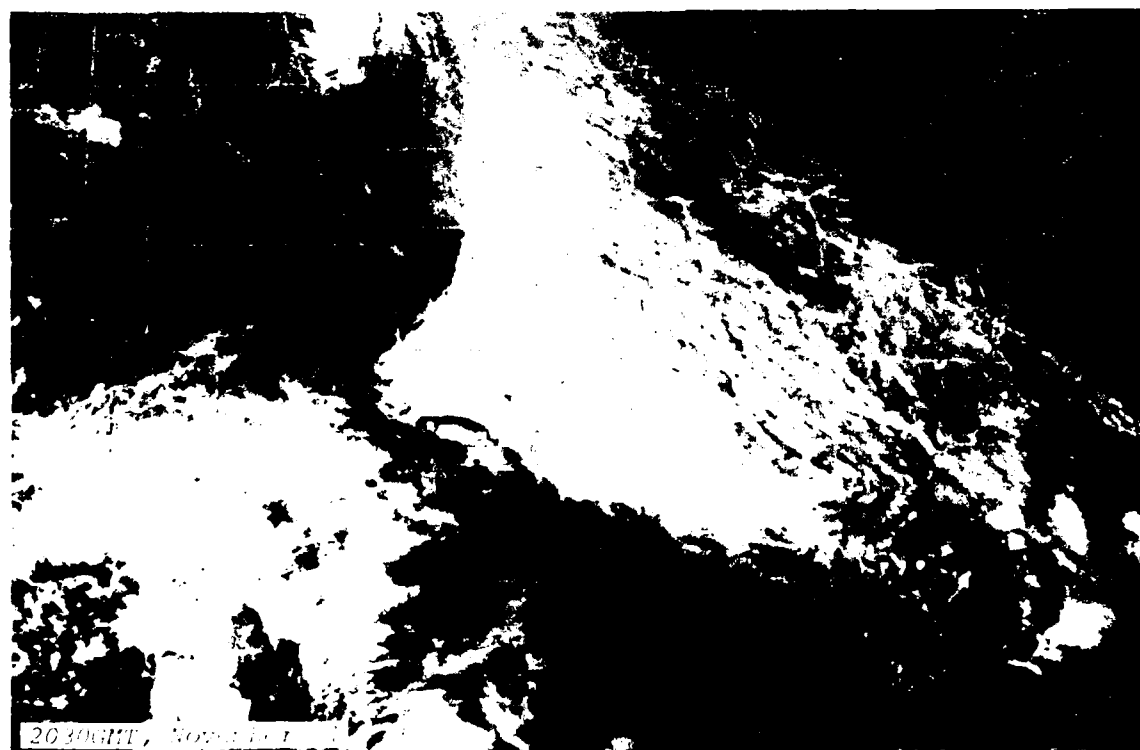
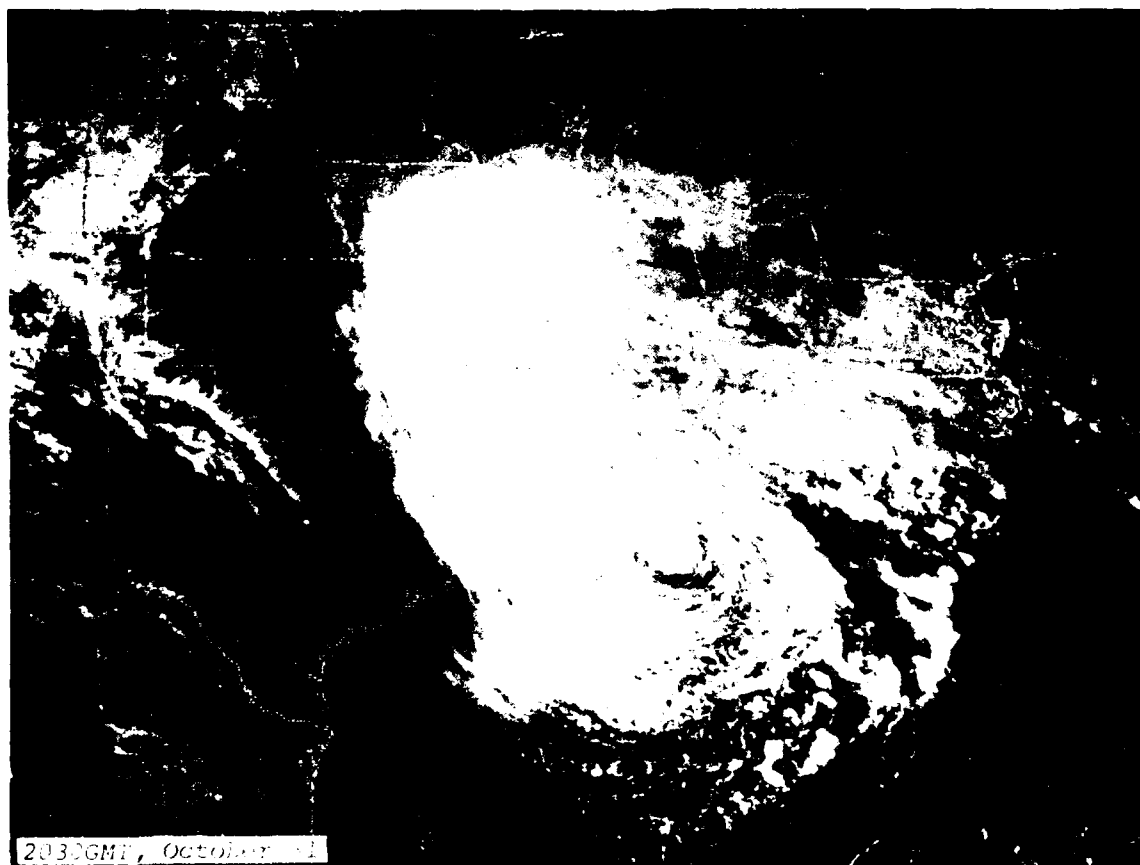


PHOTO SECTION

HURRICANE JUAN on the CENTRAL GULF COAST



HURRICANE JUAN on the CENTRAL GULF COAST: ---- continued



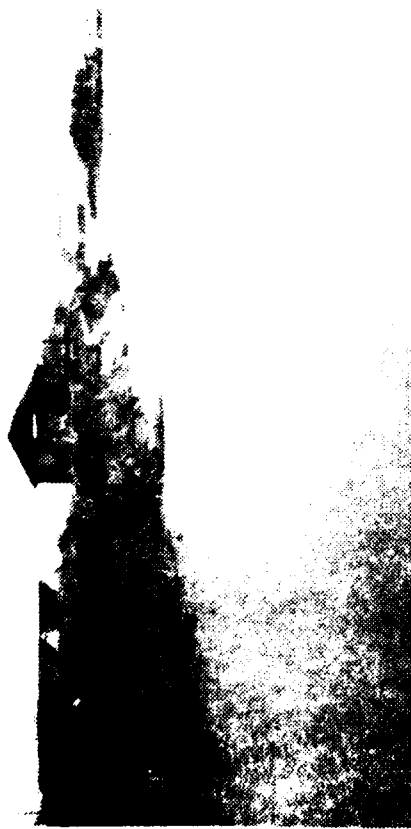


View of the field from the road
looking towards the
field and the
road.





Pine completely destroyed at
Grand Isle



Eroded pine at Grand Isle
Pine destruction at Grand Isle





Damaged Pedestrian Crossover at
Grand Isle

Pedestrian Crossover with partial
Dune Erosion



Damaged Emergency Crossover at
Grand Isle

Pedestrian Crossover intact with
Dune Destroyed





Westwego Levee Failure









V-Levee Breach

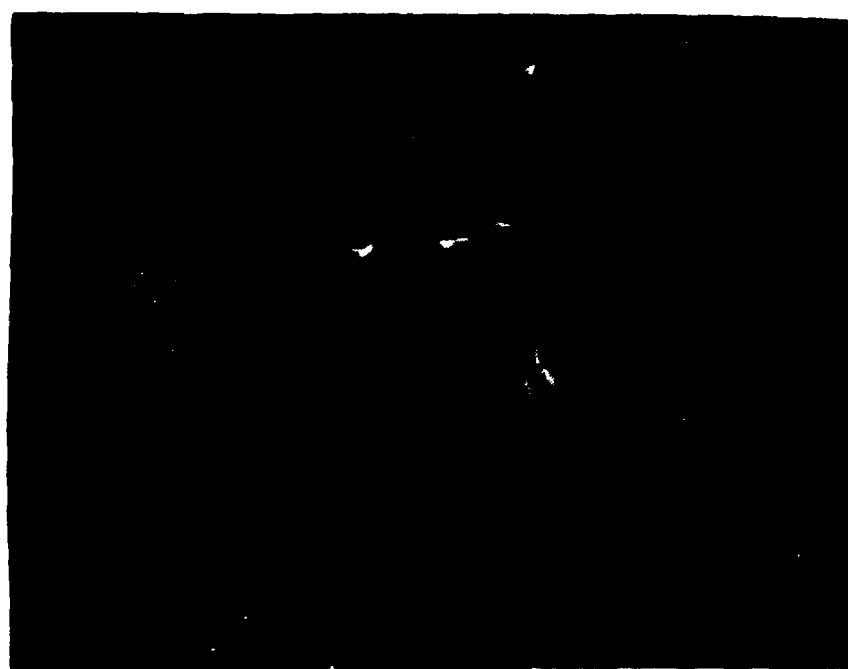




Figure 1. The
 surface of the
 rock formation.

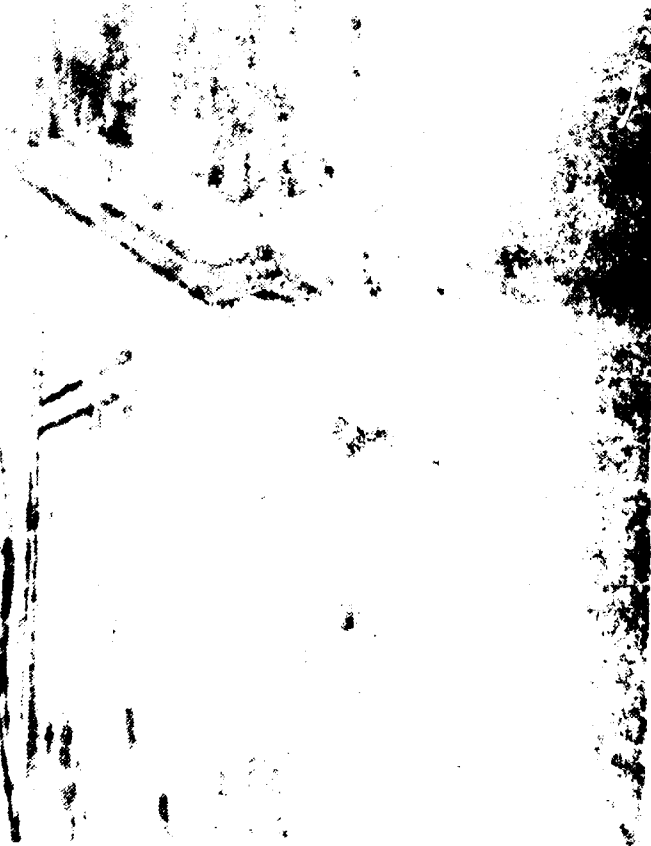


Figure 2. The
 surface of the
 rock formation.

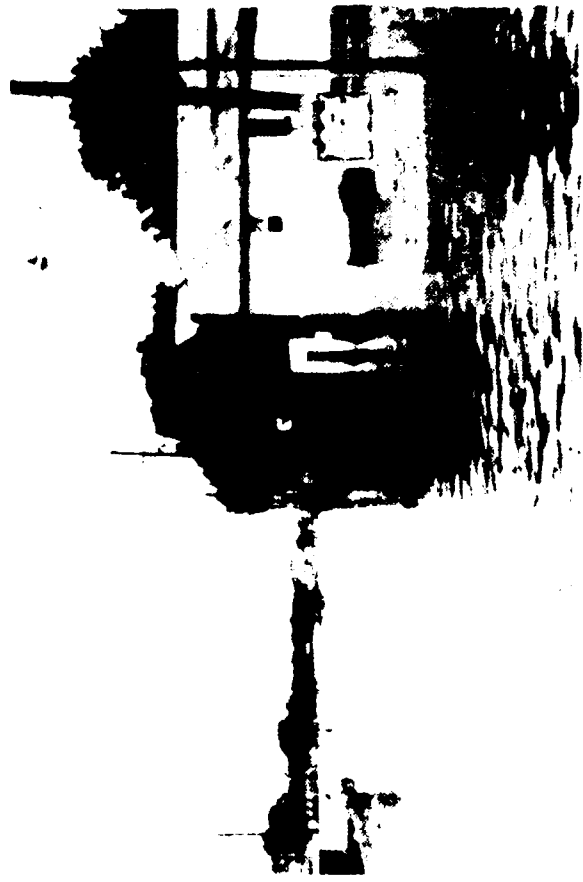




Looking at valley from
 road at base of hill
 looking at valley from
 road at base of hill



Looking at valley from
 road at base of hill





Golden Meadow Floodgate, In
Lafourche Parish

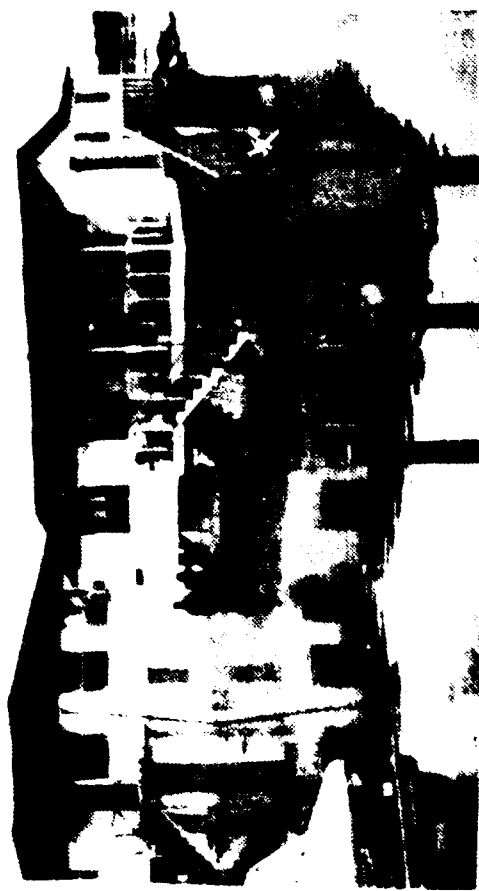
Larose Floodgate Under Construction
in Lafourche Parish





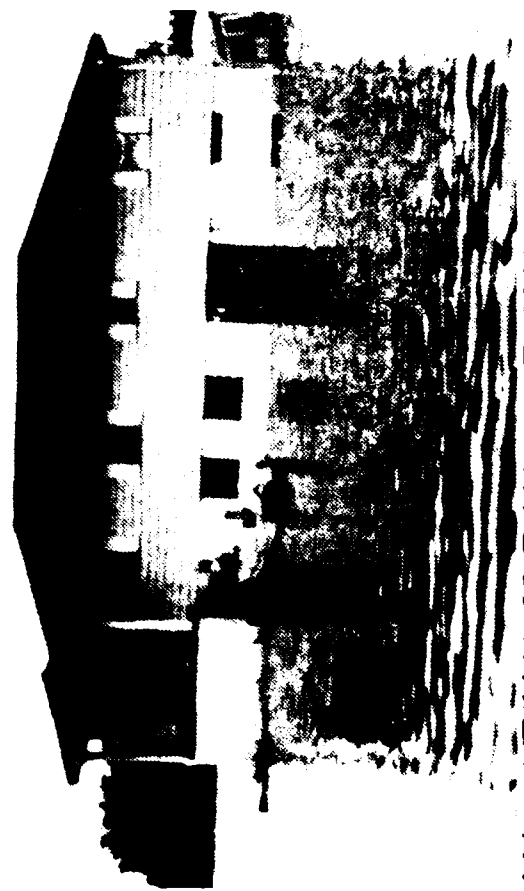
Flooding at Florissant, LA in
St. Bernard Parish

Receding Water at Yscloskey,
LA in St. Bernard Parish



Flooding at Hopedale, LA in
St. Bernard Parish

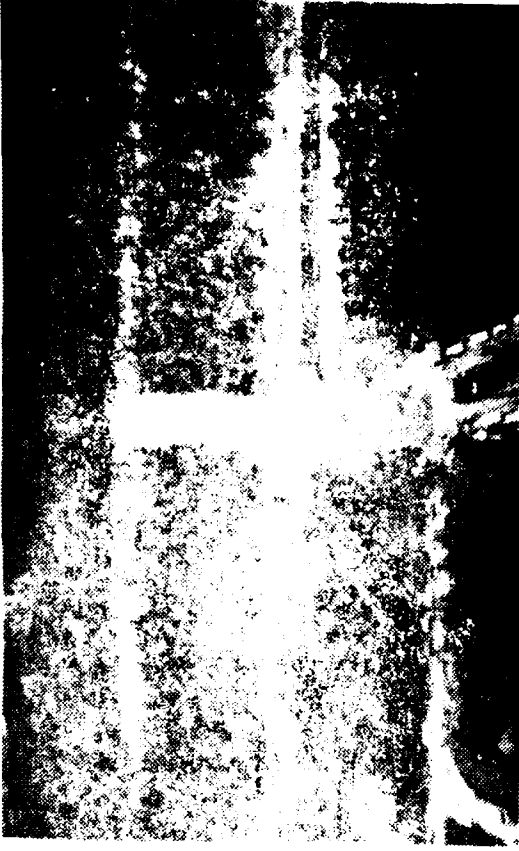
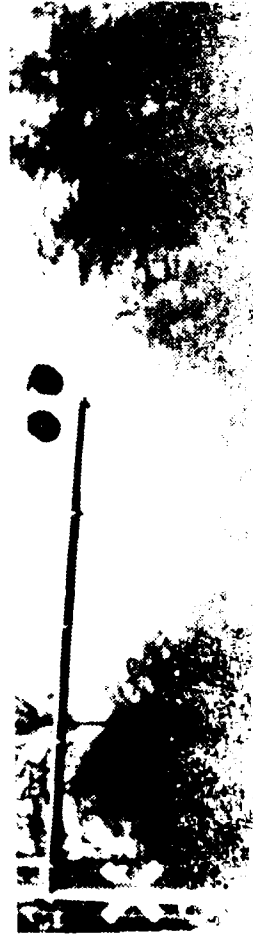
Flooding near Shell Beach, LA in
St. Bernard Parish





Volunteers Filling Sandbags at
Ormond Estates

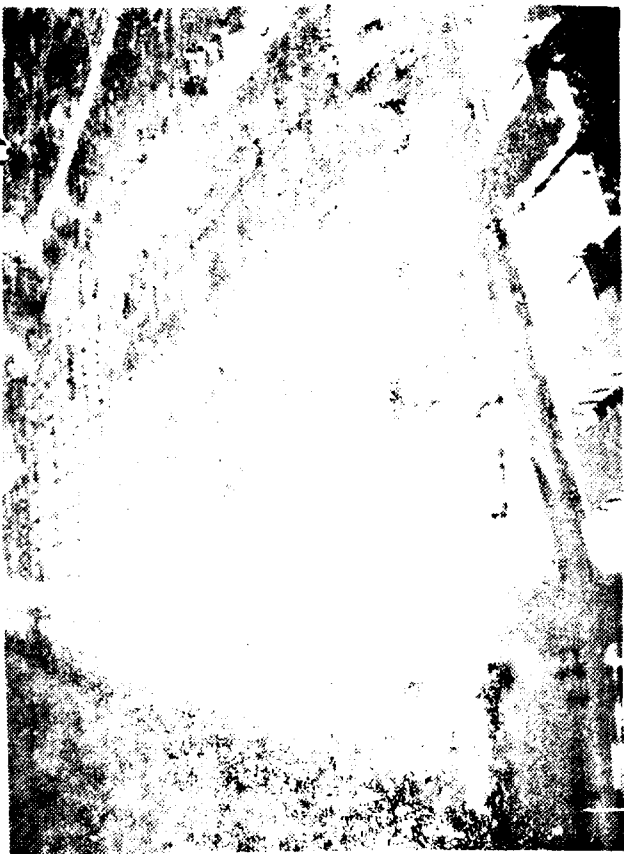
Emergency Dike Protecting Entrance
to Ormond Estates



Dike Construction Protecting Entrance
to Ormond Estates

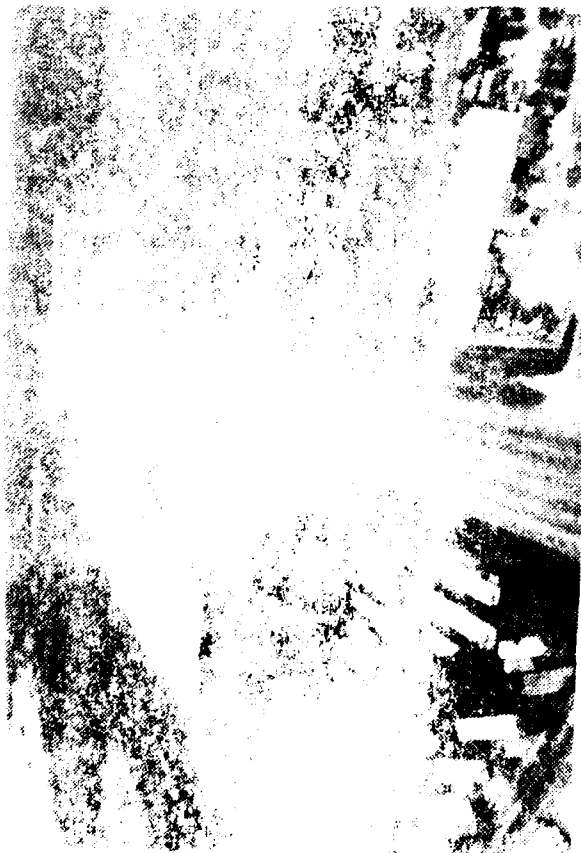
Minor Flooding-Ormond Subdivision





Flooding in Cambridge Subdivision
in Laplace

Bayou des Allemands in Lafourche Parish



Dike Across Airline Highway at
St. Charles-Jefferson Parish Line

St. Charles Parish South of
Airline Highway





Lake Pontchartrain near IHNC in
Orleans Parish

Lake Pontchartrain near Orleans Canal



END

8-87

DTIC